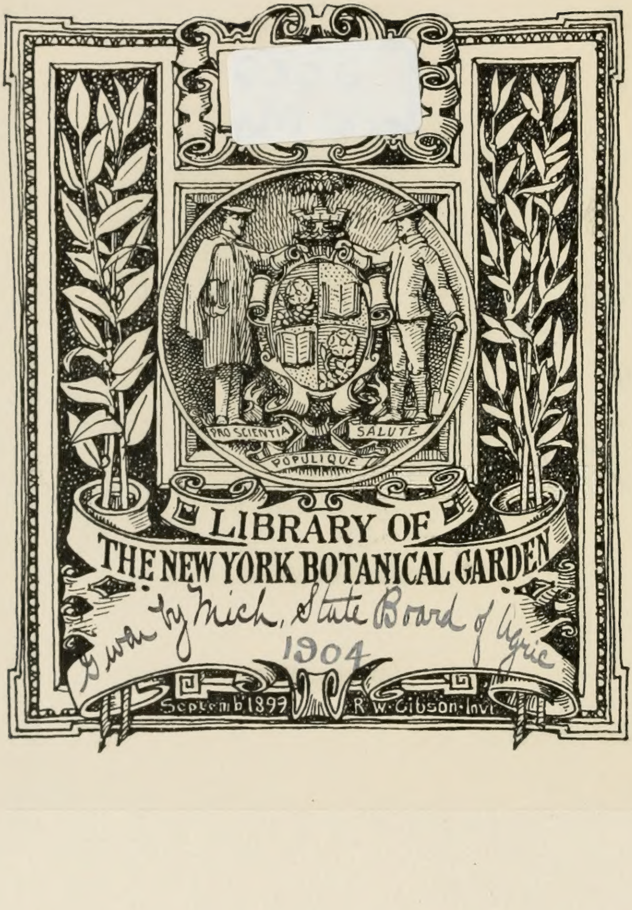


LIBRARY OF
THE NEW YORK BOTANICAL GARDEN

Given by Mich. State Board of Agric
1904

FORTY-FIRST ANNUAL REPORT

OF THE

SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

OF THE

STATE OF MICHIGAN

AND

FIFTEENTH ANNUAL REPORT

OF THE

EXPERIMENT STATION

FROM

JULY 1, 1901, TO JUNE 30, 1902.

LIBRARY
NEW YORK
BOTANICAL
GARDEN

BY AUTHORITY.

1902.
WYNKOOP HALLENBECK CRAWFORD CO. LANSING, MICH.
STATE PRINTERS.

XA
.N7772
v.41

LIBRARY
NEW YORK
BOTANICAL
GARDEN

REPORT OF THE SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

Agricultural College,
July 1, 1902.

To Honorable Aaron T. Bliss,
Governor of the State of Michigan:

Sir—I have the honor to submit to you herewith, as required by law, the accompanying report for the fiscal year ending June 30, 1902, with supplementary papers. Eleven months of this period have been covered by the administration of my predecessor in office.

Very respectfully,
ADDISON M. BROWN,
Secretary of the State Board of Agriculture.

STATE BOARD OF AGRICULTURE.

	Term expires.
THOMAS F. MARSTON, Bay City, PRESIDENT OF THE BOARD.	1903
EDWARD P. ALLEN, Ypsilanti,	1903
HOLLISTER F. MARSH, Allegan,	1905
L. WHITNEY WATKINS, Manchester,	1905
FRANKLIN WELLS, Constantine,	1907
CHARLES J. MONROE, South Haven,	1907
AARON T. BLISS, GOVERNOR OF THE STATE,	*Ex-Officio.*
JONATHAN L. SNYDER, PRES. OF COLLEGE,	*Ex-Officio.*

A. M. BROWN, } AGRICULTURAL COLLEGE, SECRETARY.
*A. C. BIRD, }
B. F. DAVIS, LANSING, TREASURER.

STANDING COMMITTEES.

The President of the Board is *ex-officio* a member of each of the Standing Committees.

FINANCE,	H. F. Marsh, C. J. Monroe.
FARM MANAGEMENT,	Franklin Wells, L. W. Watkins.
BOTANY AND HORTICULTURE,	C. J. Monroe, L. W. Watkins.
BUILDINGS AND PROPERTY,	H. F. Marsh, Franklin Wells.
EMPLOYES,	L. W. Watkins, H. F. Marsh, J. L. Snyder.
FARMERS' INSTITUTES,	E. P. Allen, C. J. Monroe.
MECHANICAL DEPARTMENT,	H. F. Marsh, C. J. Monroe.
MILITARY AND ATHLETICS,	L. W. Watkins, H. F. Marsh.
COLLEGE LAND GRANT,	E. P. Allen, Franklin Wells.
STATE WEATHER SERVICE,	C. J. Monroe, H. F. Marsh.
EXPERIMENT STATION,	L. W. Watkins, C. J. Monroe.
LIBRARY,	Franklin Wells, E. P. Allen.
WOMEN'S DEPARTMENT,	E. P. Allen, C. J. Monroe.
CHEMICAL AND OTHER ACADEMIC DEPARTMENTS NOT OTHERWISE PROVIDED FOR,	Franklin Wells, E. P. Allen.

---

* Resigned May 31, 1902.

STATE AGRICULTURAL COLLEGE.

(Under control of the State Board of Agriculture.)

FACULTY AND OTHER OFFICERS.

Jonathan L. Snyder, A. M., Ph. D., President; [a] [b] [c] Feb. 25, '96.

Robert C. Kedzie, M. A., M. D., D. Sc., LL. D., Professor of Chemistry and Curator of the Chemical Laboratory; [a] [b] [c] Feb. 25, '63.

Wm. J. Beal, A. M., M. S., Ph. D., Professor of Botany and Forestry and Curator of the Botanical Museum: [a] [b] July 9, '70; [c] Feb. 22, '71.

Levi R. Taft, M. S., Professor of Horticulture and Landscape Gardening, and Superintendent of the Horticultural Department; [a] [b] [c] Aug. 1, '88.

Howard Edwards, M. A., LL. D., Professor of English Literature and Modern Languages; [a] [b] [c] Aug. 25, '90.

Herman K. Vedder, C. E., Professor of Mathematics and Civil Engineering; [a] [b] [c] Sept. 15, '91.

Clinton D. Smith, M. S., Dean of Short Courses, College Extension Lecturer, and Superintendent of Institutes; [a] [b] Sept. 1, '93; [c] July 1, '99.

Chas. L. Weil, B. S., Professor of Mechanical Engineering and Director of the Mechanical Department; [a] [b] [c] Sept. 1, '93.

Walter B. Barrows, B. S., Professor of Zoölogy and Physiology, and Curator of the General Museum; [a] [b] [c] Feb. 15, '94.

George A. Waterman, B. S., M. D. C., Professor of Veterinary Science; [a] [b] [c] Sept. 1, '98.

Maud Gilchrist, B. S., Dean of the Women's Department: [a] [b] [c] Sept. 1, '01.

*Arthur C. Bird, B. S., M. Ag., Secretary; [a] Feb. 22, '99.

Addison M. Brown, A. B., Secretary; [a] [b] [c] June 1, '02.

Major Charles A. Vernou, U. S. A., Professor of Military Science and Tactics; [a] [b] [c] Oct. 6, '00.

Frank S. Kedzie, M. S., Adjunct Professor of Chemistry; [a] [b] Sept. 15, '80; [c] Jan. 1, '91.

William S. Holdsworth, M. S., Assistant Professor of Drawing; [a] Feb. 22, '81; [b] Aug. 22, '87; [c] Jan. 1, '90.

---

* Resigned May 31, '02.

Wilbur O. Hedrick, M. S., Assistant Professor of History and Political Economy; [a,b] Aug. 24, '91; [c] Sept. 1, '93.

Warren Babcock, B. S., Assistant Professor of Mathematics; [a,b] June 30, '91, [c] Sept. 1, '93.

Charles F. Wheeler, B. S., Assistant Professor of Botany; [a,b] Mar. 1, '90; [c] Jan. 1, '96.

Georgiana Blunt, Ph. M., Assistant Professor of English and Modern Languages; [a,b,c] Sept. 1, '98.

Ulysses P. Hedrick, M. S., Assistant Professor of Horticulture; [a,b,c] Sept. 1, '99.

Joseph A. Jeffery, B. S. Agr., Assistant Professor of Agriculture; [a,b,c] Sept. 1, '99.

Martin D. Atkins, A. B., Assistant Professor of Physics and Electrical Engineering; [a,b,c] Sept. 1, '99.

Charles E. Marshall, Ph. B., Assistant Professor of Bacteriology and Hygiene; [a,b] Sept. 1, '98; [c] Sept., '00.

*Hugo Diemer, M. E., Assistant Professor of Mechanical Engineering; [a,b,c] Sept. 1, '00.

George E. Denman, Director of Physical Culture; [a,b,c] Sept. 1, '01.

Mrs. Linda E. Landon, Librarian; [a,b,c] Aug. 24, '91.

Burton O. Longyear, Instructor in Botany; [a,b,c] Feb. 15, '94.

Rufus H. Pettit, B. S. Agr., Instructor in Zoölogy; [a,b,c] Feb. 1, '97.

Mrs. Maud A. Marshall, Instructor in Music; [a,b,c] Sept. 1, '97.

Mrs. Jennie L. K. Haner, Instructor in Sewing; [a,b,c] Sept. 1, '97.

Caroline L. Holt, Instructor in Drawing; [a,b,c] Sept. 1, '98.

Chace Newman, Instructor in Mechanical Drawing; [a,b] Sept. 1, '97; [c] July 23, '01.

John J. Ferguson, B. S. Agr., Instructor in Animal Husbandry; [a,b] Sept. 1, '99; [c] Sept. 1, '01.

Belle C. Crowe, Instructor in Domestic Science; [a,b,c] Oct. 1, '99.

E. Sylvester King, Instructor in English; [a,b,c] Jan. 1, '00.

Albert H. Taylor, Instructor in Physics; [a,b,c] Sept. 1, '00.

Herman W. Reynolds, B. S. in M. E., Instructor in Mechanical Engineering; [a,b,c] Sept. 1, '00.

Leslie L. Locke, M. A., Instructor in Mathematics; [a,b,c] Sept. 1, '00.

Alfred H. Parrot, M. A., Instructor in Mathematics; [a,b,c] Sept. 1, '00.

Bertha M. Wellman, B. S., B. Pd., Instructor in English; [a,b,c] Sept. 1, '00.

Jesse J. Myers, B. S., Instructor in Zoölogy; [a,b,c] Sept. 1, '01.

S. Fred Edwards, B. S., Instructor in Bacteriology and Hygiene; [a,b,c] Sept. 1, '00.

John Michaels, B. S. Agr., Instructor in Dairying; [a,b,c] Sept. 1, '00.

Carrie A. Lyford, B. L., Instructor in Cookery; [a,b,c] Sept. 1, '00.

---

* Resigned Aug. 1, '01.

SARAH B. S. AVERY, Instructor in Gymnastics; [a] [b] [c] Sept. 1, '00.

PHILLIP H. STEPHENS, A. B., Instructor in English; [a] [b] [c] Sept. 1, '01.

THOMAS GUNSON, Instructor in Floriculture and Foreman of Greenhouse; [a] [b] April 1, '91; [c] March 1, '01.

GEORGE HUMPHREY, B. S., Instructor in Animal Husbandry, [a] [b] [c] Sept. 1, '01.

GEORGE SEVERANCE, B. S., Instructor in Agriculture; [a] [b] [c] Sept. 1, '01.

WALTER W. WELLS, B. S., Instructor in Mechanical Engineering, [a] [b] [c] Sept. 1, '01.

ROWENA KETCHAM, in charge of College Hospital; [a] [b] [c] Sept. 1, '00.

FRED C. KENNEY, Cashier; [a] [b] Sept. 18, '95; [c] Oct. 1, '97.

W. R. BRADFORD, Foreman of Wood Shop; [a] [b] [c] Nov. 1, '97.

W. S. LEONARD, Foreman of Machine Shop; [a] [b] [c] Sept. 1, '96.

E. C. BAKER, Foreman of Foundry; [a] [b] [c] Nov. 1, '97.

E. R. BLAIR, Foreman of Farm; [a] [b] [c] Sept, 1, '99.

PAUL THEODORE, Foreman of Forge Shop.

HENRY SHERMAN, Foreman of Grounds; [a] [b] [c] Sept. 1, '01.

B. A. FAUNCE, Clerk to President; [a] [b] [c] Sept. 1, '99.

CLARA A. HINMAN, Bookkeeper; [a] [b] [c] May 1, '99.

JULIA M. BALDWIN, Clerk to Secretary; [a] [b] [c] Feb. 1, '98.

L. F. NEWELL, Engineer; [a] [b] [c] Jan. 1, '98.

E. A. BOWD, Architect; [a] [b] [c] Jan. 1, '02.

---

[a] First appointment.
[b] Present appointment.
[c] Present title.

AGRICULTURAL EXPERIMENT STATION

OF THE

MICHIGAN AGRICULTURAL COLLEGE.

(Under the control of the State Board of Agriculture.)

STATION COUNCIL.

Clinton D. Smith, M. S., - Director.
*J. D. Towar, B. S., - Agriculturist.
L. R. Taft, M. S., - Horticulturist.
Rob't C. Kedzie, M. A., M. D., D. Sc., LL. D., - - - Chemist.
Chas. E. Marshall, Ph. B. - Bacteriologist and Hygienist.
†A. C. Bird, B. S., M. Ag., } Sec and Treas.
A. M. Brown, A. B. }
J. L. Snyder, M. A., Ph. D., Pres., *Ex-officio* Member.

ADVISORY AND ASSISTANT STAFF.

M. L. Dean, - Assist. in Horticulture.
‡L. H. Van Wormer, B. S., - - Assistant in Chemistry.
F. W. Robison, B. S., - - - - Assistant in Chemistry.
Geo. A. Waterman, V. S., M. D. C., Consulting Veterinarian.
Chas. F. Wheeler, B. S., - - Consulting Botanist.
R. H. Pettit, B. S. A., Consulting Entomologist.
§S. H. Fulton, B. S., } In charge of South Haven sub-station
T. A. Farrand. }
Mrs. L. E. Landon, - - Librarian.
S. Fred Edwards, B. S., - - Assist. in Bacteriology and Hygiene.
Leo M. Geismer, Chatham, in charge of Upper Peninsula Experiment Station.

SUB-STATIONS.

Grayling, Crawford county, 80 acres deeded.
South Haven, Van Buren county, 10 acres rented; 5 acres deeded; Local Agent, T. A. Farrand.
Chatham, Alger county, 160 acres deeded; Local Agent, Leo M. Geismer.

STATE WEATHER SERVICE.

(Under the control of the State Board of Agriculture.)

OFFICERS OF THE SERVICE.

Director, - - - - C. F. Schneider, U. S. Weather Service, Lansing.

STANDING COMMITTEE IN CHARGE.

Hon. Charles J. Monroe, - - - - - - - - - South Haven.
Hon. Hollister F. Marsh, - - - - - - - - - - Allegan.

---

* Resigned May 1, '02. † Resigned May 31, '02. ‡ Resigned Dec. 10, '01. § Resigned Nov. 1, '01.

ACCOUNTS OF THE STATE AGRICULTURAL COLLEGE.

FOR THE YEAR ENDING JUNE 30, 1902.

SECRETARY'S FINANCIAL REPORT.

			Dr.	Cr.
July 1, 1901.	To cash on hand		$47 65	
July 1, 1901.	To cash on deposit, college treasurer		1,029 89	
June 30, 1902.	To special appropriation receipts:			
	From State Treasurer	$14,000 00		
	From United States Treasurer	15,000 00		
	From institution and other sources	6,213 01	35,213 01	
June 30, 1902.	By special appropriation disbursements			$28,499 28
June 30, 1902.	To current account receipts:			
	From State Treasurer, land grant interest	$65,000 00		
	One-tenth mill tax	25,000 00		
	From United States Treasurer	25,000 00		
	From institution and other sources	42,674 27	157,674 27	
June 30, 1902.	By general account disbursements:			
	Current account	$144,837 82		
	Supplementary accounts	12,860 29		157,698 11
June 30, 1902.	By cash on deposit, college treasurer			6,536 46
June 30, 1902.	By cash on hand			1,230 97
			$193,964 82	$193,964 82

TABLE NO. 1.—*Tabular exhibit of secretary's report.*

	Balance sheet. July 1, 1901.		Transactions, July 1, 1901, to June 30, 1902.		Balance sheet. June 30, 1902.	
	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Cash	$47 65			$1,183 32	$1,230 97	
College treasurer*	1,029 89			5,506 57	6,536 46	
Special appropriations		$461 39	$35,213 01	28,499 28		$7,708 15
Current accounts		616 15	157,674 27	144,837 82		59 28
Supplementary accounts				12,860 29		
Totals	$1,077 54	$1,077 54	$192,887 28	$192,887 28	$7,767 43	$7,767 43

*Treasurer's statement is greater July 1, 1901, by outstanding warrants $4,615.10, less credits by remittance in transit of $1,913.23 and interest not credited, $14.62, and June 30, 1902, by $3,748.20.

TREASURER'S ACCOUNT.

	Dr.	Cr.
Balance on hand July 1, 1901	$3,746 38	
Receipts from State Treasurer and secretary	195,636 73	
Interest on deposits, 12 months at 2%	182 81	
Warrants paid July 1, 1901, to June 30, 1902		$189,281 26
Balance on hand June 30, 1902		10,284 66
	$199,565 92	$199,565 92

TABLE NO. 2.—*Statement of special appropriation account for fiscal year July 1, 1901, to June 30, 1902.*

Name of appropriation.	Balance of accounts, July 1, 1901.		Receipts during fiscal year.		Total available.	Total expended.	Balance of account, June 30, 1902.	
	Dr.	Cr.	From state treasury.	From institution and other sources.			Dr.	Cr.
Experiment station		$616 15	*$15,000 00	$5,743 01	$21,359 16	$21,234 21		$124 95
Weather service		26 87	1,000 00		1,026 87	960 32		66 55
Bacteriological laboratory			10,000 00		10,000 00	3,935 65		6,064 35
Nursery license and inspection		100 00		270 00	370 00	285 00		85 00
Power plant			3,000 00		3,000 00	1,632 70		1,367 30
Women's building				200 00	200 00	200 00		
Dairy building		251 40			251 40	251 40		
Balance	$994 42						7,708 15	
Total	$994 42	$994 42	$29,000 00	$6,213 01	$36,207 43	$28,499 28	$7,708 15	$7,708 15

* $15,000 from United States Treasury.

TABLE NO. 3.—*Current account July 1, 1901, to June 30, 1902.*

On account of—	Dr. To disbursements.	Cr. By receipts.
U. S. Treasurer, thirteenth annual payment under act of congress of August 30, 1890		$25,000 00
State Treasurer, one-tenth mill tax		25,000 00
State Treasurer interest on proceeds of sales of U. S. land grant		65,000 00
Salaries paid	$55,831 53	
Farm department	19,629 62	14,679 24
Horticultural department	5,263 68	2,273 31
Mechanical department	6,338 74	1,423 93
Heating department	13,827 02	2,215 67
Cleaning department	1,552 99	277 81
Electric lighting department	2,794 95	937 88
Office	1,220 39	65 89
Advertising	1,779 16	2 00
M. A. C. Record	827 54	486 40
Special courses	1,568 48	236 08
Academic departments	12,466 93	3,128 64
Contingent building	18,128 69	15,367 92
Miscellaneous	2,250 06	1,157 44
Green house additions	1,149 04	
Farmers' institutes	6,670 87	
Bulletins	3,076 88	
South Haven experiment station	610 99	44 62
Upper Peninsula experiment station	2,501 55	168 44
	$157,489 11	$157,465 27
Balance at beginning of period July 1, 1901		83 12
Balance at close of period June 30, 1902	59 28	
Total	$157,548 39	$157,548 39

TABLE NO. 4.—*Experiment station account, July 1, 1901, to June 30, 1902.*

On account of—	Dr. To disbursements.	Cr. To receipts.
Balance from last fiscal year, July 1, 1901		$616 15
U. S. Treasurer for fiscal year		15,000 00
Fertilizer license fees		1,860 00
Salaries paid	$8,778 11	
Farm department	4,790 87	2,736 08
Horticultural department	602 83	108 44
Chemical department	738 30	
Botanical department	13 24	
Entomological department	194 71	
Library	158 91	
Sundry	1,510 73	788 36
Secretary's office	712 93	
South Haven sub-station	859 69	193 43
Bacteriological department	1,174 67	56 70
Bacteriological stable	1,699 22	
Balance on hand June 30, 1902, close of fiscal year	124 95	
Total	$21,359 16	$21,359 16

TABLE NO. 5.—*Regular employes and salaries.*

Officers.	Rate per year.	Classification.		Other sources.	
		Current.	Experim't station.		
President	$3,200 00	$3,200 00			Dwelling.
Professor of chemistry	2,000 00	1,700 00	$300 00		“
“ “ botany	1,800 00	1,800 00			“
“ “ horticulture	1,800 00	400 00	1,400 00		“
“ “ English	2,000 00	2,000 00			
“ “ mathematics	1,800 00	1,800 00			Dwelling.
College extension lecturer, director of experiment station and Supt. Farmers' Institutes.	2,000 00	1,000 00	1,000 00		“
Professor of mechanical engineering	1,800 00	1,800 00			“
“ “ zoology	1,800 00	1,800 00			“
“ “ veterinary science	1,500 00	1,200 00	300 00		
Dean of women's department	1,200 00	1,200 00			Rooms.
Secretary	1,800 00	300 00	500 00	$1,000 00	Dwelling.
Professor of military science	576 00	576 00			
Adjunct professor of chemistry	1,800 00	1,800 00			
Assistant professor drawing	1,350 00	1,350 00			Rooms.
“ “ his. and pol. economy	1,100 00	1,100 00			“
“ “ mathematics	1,100 00	1,100 00			“
“ “ botany	1,100 00	550 00	550 00		“
“ “ English	1,050 00	1,050 00			
“ “ horticulture	1,500 00	1,500 00			Rooms.
“ “ agriculture	1,500 00	1,500 00			
“ “ physics	1,450 00	1,450 00			Rooms.
“ “ bacteriology	1,500 00	500 00	1,000 00		
Director physical culture	1,100 00	1,100 00			
Librarian	1,000 00	880 00	120 00		Rooms.
Instructor in botany	600 00	600 00			
“ “ zoology	1,000 00	500 00	500 00		House.
“ “ mechanical engineering	1,050 00	1,050 00			
“ “ music	600 00	600 00			
“ “ sewing	700 00	700 00			Room.
“ “ mathematics	550 00	550 00			
“ “ “	550 00	550 00			
“ “ mechanical drawing	600 00	600 00			
“ “ drawing	600 00	600 00			
“ “ animal husbandry	1,200 00	1,200 00			
“ “ “ “	550 00	550 00			
“ “ agriculture	500 00	500 00			Room.
“ “ domestic science	800 00	800 00			“
“ “ English	900 00	900 00			
“ “ “	500 00	500 00			
“ “ physical culture	500 00	500 00			Rooms.
“ “ cookery	500 00	500 00			“
“ “ dairying	700 00	700 00			“
“ “ physics	550 00	550 00			
“ “ bacteriology	350 00	275 00	75 00		
“ “ English	500 00	500 00			
“ “ zoology	500 00	500 00			
“ “ mechanical engineering	600 00	600 00			
Foreman greenhouse	1,000 00	1,000 00			Dwelling.
“ machine shop	1,000 00	1,000 00			
“ wood shop	750 00	750 00			
“ foundry	700 00	700 00			
Cashier	1,000 00	800 00	200 00		
Foreman college farm	550 00	550 00			
“ horticulture department	480 00	480 00			Dwelling.
Clerk to president	600 00	600 00			
Engineer	800 00	800 00			Dwelling.
Architect	1,500 00	1,500 00			
Bookkeeper	600 00	500 00	100 00		
Clerk to secretary	500 00	375 00	125 00		
“ “ mechanical department	480 00	480 00			
Assistant gardener	700 00	100 00	600 00		
Agriculturist	1,500 00		1,500 00		
Assistant chemist	1,000 00		1,000 00		
Stenographer to director experiment station	450 00	225 00	225 00		
“ “ Supt. farm department	420 00	420 00			
Assistant librarian	300 00	300 00			
Night watchman	480 00	480 00			
Nurse in charge college hospital	450 00	450 00			
Total	$68,986 00	$58,491 00	$9,495 00	$1,825 00	

‡ TABLE NO. 6.—*Detailed statement of legislative*

Object.	Total.	1899.	1897.	1895.	1893.
Buildings		Woman's dormitory $83,000 Heating and furnishing dormitory 12,000 Dairy building 15,000 Farm barn 4,000 Heating apparatus 2,500 Fire escapes 500	Electric light plant $5,000 Bath room, Abbot hall 200	Closets	Equip. botanical lab. $1,000 Foundry 1,500 Hospital 2,500
Total for buildings	$351,325 00	$117,000 00	$5,200 00	$3,000 00	$5,000 00
General account	466,655 57				
Repairs	87,388 60	10,000 00	12,000 00	12,000 00	13,500 00
Library	25,055 00				2,000 00
Farm	26,175 64				900 00
Garden	11,991 00				200 00
Greenhouse	2,765 00				
Botany	5,331 00				
Chemistry	13,955 00				
Zoölogy	10,296 00				225 00
Veterinary	2,586 00				
Mathematics	6,090 00				500 00
Mechanical	15,200 00				
Steam and water	20,832 00				
Institutes	41,800 00	11,000 00	11,000 00	10,000 00	4,000 00
Student labor	58,000 00	5,000 00	5,000 00	8,000 00	8,000 00
Weather service	22,937 50	2,000 00	2,000 00	2,000 00	
Sundry	8,960 00				3,400 00
Totals	$1,173,343 31	$145,000 00	$35,200 00	$35,000 00	$37,725 00
Annual tax on each $1,000 of assessment	† $0.035	$0.0656	$0.0155	$0.0155	$0.01⅔
*Aggregate tax to date on each $1,000 of assessment		$2.2301	$2.0989	$2.0679	$2.0369
Assessed valuation of State in millions of dollars		1,105.10	1,105.10	1,130	1,130

---

* Counting only taxes actually levied and omitting land grants.

† Average.

‡ The legislature of 1901 provided for a permanent annual income of $100,000 in lieu of special legislative appropriations except $1,000 for the State weather service.

appropriations to the State Agricultural College.

1891.	1889.	1887.	1885.	1886.	1881.	1879.	1877.	1855-75.
Botanical laboratory.... $10,000 Heating apparatus...... 1,950 Greenhouse........... 4,500	Agricultural laboratory. $8,000 Sundry................. 1,800	Howard terrace......... $10,000 Abbot hall.............. 10,000 Horticultural lab....... 5,000 Mechanical laboratory.. 3,000 Bridge, etc............. 2,100	Mechanical laboratory.. $7,800 Veterinary laboratory.. 5,400 Armory.................. 5,000 One dwelling............ 4,000	Boiler house........... $5,000 One dwelling........... 3,000	Library................ $25,000 Chemical lab. addition. 6,000 Barns.................. 2,775	Botanical laboratory.... $6,000 One dwelling........... 3,000	Wells hall............... $25,000	Williams hall, 1869..... $39,000 Chemical lab., 1871..... 10,000 Greenhouse, 1873........ 8,000 Three dwellings......... 18,000 Bridges................. 800
$16,450 00	$9,800 00	$30,100 00	$22,200 00	$8,000 00	$33,775 00	$9,000 00	$25,000 00	$66,800 00
....	....	....	....	16,770 00	14,498 00	9,943 60	12,300 00	413,143 97
7,800 00	5,000 00	1,400 00	3,147 00	6,720 00	1,576 00	1,290 00	3,691 60	9,264 00
2,000 00	3,000 00	3,000 00	3,300 00	3,125 00	3,000 00	2,060 00	1,190 00	2,440 00
2,100 00	800 00	2,815 00	4,810 00	3,389 00	4,175 00	4,016 64	2,400 00	1,670 00
570 00	500 00	1,250 00	432 00	1,342 00	3,220 00	2,810 00	947 00	720 00
530 00	600 00	340 00	1,295 00	....	....	....	....	....
500 00	1,000 00	800 00	800 00	2,231 00	....	....	....	....
500 00	1,500 00	2,000 00	2,500 00	1,000 00	3,000 00	1,000 00	1,380 00	1,075 00
700 00	1,500 00	1,500 00	1,500 00	1,945 00	1,000 00	800 00	480 00	646 00
100 00	200 00	200 00	2,086 00	....	....	....	....	....
200 00	475 00	600 00	450 00	700 00	2,020 00	1,020 00	125 00	....
1,500 00	3,200 00	4,000 00	5,200 00	1,000 00	300 00	....	....	....
2,045 00	2,920 00	7,500 00	1,400 00	4,267 00	....	....	....	2,700 00
1,500 00	800 00	600 00	600 00	600 00	600 00	600 00	500 00	....
8,000 00	8,000 00	8,000 00	8,000 00	....	....	....	....	....
....	8,350 00	8,587 50	....	....	....	....	....	....
1,400 00	500 00	2,100 00	....	....	....	600 00	660 00	300 00
$45,895 00	$48,145 00	$74,792 50	$57,720 00	$51,089 00	$67,164 00	$33,080 24	$48,673 60	$498,758 97
$0.02	$0.02½	$0.04	$0.03⅓	$0.04⅐	$0.04⅐	$0.02⅝	$0.04	$0.0747
$2.0036	$1.963	$1.912	$1.833	$1.7657	$1.7026	$1.6197	$1.5672	$1.4407
1,330	945.15	945.45	810	810	810	630	630	137 to 630

TABLE NO. 7.—*Income of the State Agricultural College from all outside sources from the date of its foundation to the present time.*

Year.	From State Legislature.			From U. S. Congress.			Total.
	For current expenses.	For special purposes.	Land sales salt spring and swamp land grants.	Morrill act of 1862, interest from land grant and trespass.	Hatch act of 1887, experiment station.	Morrill act of 1890, supplementary endowment.	
1855			$56,320 00				$56,320 00
1856							
1857	$40,000 00						40,000 00
1858							
1859	37,500 00						37,500 00
1860							
1861	6,500 00		152 25				6,652 25
1862	10,000 00		218 97				10,218 97
1863	9,000 00		407 80				9,407 80
1864	9,000 00		726 09				9,726 09
1865	15,000 00		1,156 61				16,156 61
1866	15,000 00		1,094 27				16,094 27
1867	20,000 00		7,608 38				27,608 38
1868	20,000 00		592 49				20,592 49
1869	20,000 00	$30,000 00	17,559 00	$58 96			67,617 96
1870	20,000 00		1,320 02	2,720 93			24,040 95
1871	18,250 00	10,500 00	4,135 72	3,785 84			36,671 56
1872	18,250 00	3,000 00	217 05	7,175 65			28,642 70
1873	21,796 00	15,602 00	10 13	11,059 06			48,467 19
1874	13,000 00	15,602 00	150 13	14,061 98			42,814 11
1875	7,638 00	7,755 50	144 53	14,446 14			29,984 17
1876	7,638 00	6,755 50	1,773 09	16,830 17			32,996 76
1877	6,150 00	30.686 80	979 06	15,172 86			52,988 72
1878	6,150 00	5,686 80	826 60	15,807 09			28,470 49
1879	4,971 80	16,068 32	712 22	16,978 22			38,730 56
1880	4,971 80	7,068 32	797 55	17,837 24			30,674 91
1881	7,249 00	43,720 50	461 95	20,935 25			72,366 70
1882	7,249 00	8,945 50	358 46	22,507 45			39,060 41
1883	8,385 00	23,793 00	391 95	30,749 60			63,319 55
1884	8,385 00	10,526 00	1,259 90	27,909 72			48,080 62
1885		35,103 00	187 50	29,770 40			65,060 90
1886		22,617 00		30,461 04			53,078 04
1887		* 44,040 00	† 198 20	† 24,611 37			68,849 57
1888		30,752 50	144 20	32,406 60	$15,000 00		78,303 30
1889		* 20,973 00	10 50	31,322 69	15,000 00		67,306 19
1890		* 27,172 00	238 50	32,360 64	15,000 00	$15,000 00	89,771 14
1891		22,947 50	37 38	34,750 54	15,000 00	16,000 00	88,735 42
1892		22,947 50	137 38	34,948 12	15,000 00	17,000 00	90,033 00
1893		18,862 50	10 50	37,927 04	15,000.00	18,000 00	89,800 04
1894		18,862 50	433 59	44,527 26	15,000 00	19,000 00	97,823 35
1895		‡ 19,000 00	10 50	45,301 85	15,000 00	20,000 00	99,312 35
1896		‡ 16,000 00		43,886 40	15,000 00	21,000 00	95,886 40
1897		‖ 17,700 00		43,779 54	15,000 00	22,000 00	98,479 54
1898		¶ 17,500 00		47,508 28	15,000 00	23,000 00	103,008 28
1899		§ 8,750 00	705 00	52,526 11	15,000 00	24,000 00	100,981 11
1900		§ 72,500 00	175 00	72,298 38	15,000 00	25,000 00	184,973 38
1901‖‖		§ 72,500 00		63,976 79	15,000 00	25,000 00	176,476 79
1902	100,000 00	¶¶ 1,000 00		64,081 81	15,000 00	25,000 00	205,081 81
Totals.	$462,083 60	$724,937 74	$101,662 47	$1,004,481 02	$225,000 00	$270,000 00	$2,788,134 83

[*] Including appropriations for weather service.
[†] October 1, 1886, to June 30, 1887, nine months.
[‡] Including $5,000 for institutes and $1,000 for weather service.
[§] Including $2,750 for institutes and $500 for weather service.
[‖] Including $5,500 for institutes and $1,000 for weather service.
[¶] Including $5,500 for institutes and $1,000 for weather service.
[‖‖] To June 30.
[¶¶] Weather service.

SUMMARY OF INVENTORY, JUNE 30, 1902.

College farm and park, 671 acres @ $70		$46,970 00
Athletic field and drive, 13 acres @ $87.50		1,137 50
Buildings—		
Library and museum, built 1881	$22,000 00	
College hall, built 1856	17,000 00	
Williams hall, built 1869	30,000 00	
Wells hall, built 1877	20,000 00	
Abbot hall, built 1888, add. in 1896	15,000 00	
Chemical laboratory, built 1871, south end add. '81	18,000 00	
Machine shops and foundry, 1885, so. end add. '87	15,000 00	
Veterinary laboratory, built 1885	5,000 00	
Horticultural laboratory, built 1888	6,000 00	
Agricultural laboratory, built 1889, imp. 1897	7,500 00	
Botanical laboratory, built 1892	10,000 00	
Armory, built 1885	6,000 00	
Greenhouse and stable, built 1873, 1879; rebuilt '92	6,000 00	
Greenhouse, experiment, built 1889	1,300 00	
Boiler house and chimney, built 1893-4	4,000 00	
President's and two frame dwellings, built 1874	12,000 00	
Four brick dwellings, built 1857	10,000 00	
Two brick dwellings, built 1879 and 1884	6,000 00	
One frame dwelling, built 1885	3,500 00	
Howard terrace dwelling, built 1888	13,000 00	
Farm house dwelling, built 1869	2,000 00	
Herdsman's dwelling, built 1867	400 00	
Ten barns at professors' houses	2,000 00	
Horticultural barn and shed, built 1868, 1875, 1887	1,200 00	
Cattle barn and shed, built 1862	1,500 00	
Sheep barn, built 1865	1,000 00	
Horse barn, built 1871	1,000 00	
Pig barn, built 1871	1,000 00	
Corn barn, built 1878	400 00	
Grain barn, built 1881	1,600 00	
Horse sheds, built 1894	200 00	
Tool barn, built 1881	1,000 00	
Barn, built 1884	800 00	
Brickwork shop, built 1857	500 00	
Observatory, built 1880	150 00	
Bath house and fittings, built 1889	400 00	
Ice house, 1879	100 00	
Paint shop, built 1879	150 00	
Bee house, 1884, remodeled dwelling, 1893, add. 1900	1,000 00	
Hospital, 1894	3,000 00	
Poultry building and yards, 1894	625 00	
Dairy barn, built 1897	800 00	
Waiting room street car terminus, built 1897	80 00	
Street car track and fixtures, 600 ft., built 1897	360 00	
Lumber shed, mechanical department	250 00	
Silo	210 00	
Coal shed, built 1899	700 00	
Woman's building, built 1900	91,000 00	
Farm barn, built 1900	4,000 00	
Dairy building, built in 1900	15,000 00	
		359,725 00
Iron bridge over Cedar river, built 1888		1,500 00
Amount carried forward		$409,332 50

Amount brought forward		$409,332 50
Water works and steam works—		
Artesian well and connections, sunk '87, 343 ft. deep	$1,000 00	
Artesian well and connections, sunk '99, 345 ft. deep	650 00	
Firepump, 1883, $650; tank pump, 1881, $200	850 00	
Three hose carts and 4 nozzles, bought 1883-88-00	99 00	
2,378 ft. wood pipe, 6 in., laid 1883-87 2,623 ft. wood pipe, 4 in., laid 1883-87 662 ft. wood pipe, 3 in., laid 1883-87	1,531 00	
1,500 ft. wrought iron pipe, 3 in., laid in 1898	360 00	
One thousand feet fire hose	80 00	
Water tank and heater, built 1883	518 00	
Thirteen fire hydrants in place, built 1883-87	460 00	
Valves, fittings and connections, laid 1883-87	650 00	
Four boilers, 4 ft. x 12 ft., built 1881	844 00	
Two boilers 5 ft. x 12 ft., built 1887	1,080 00	
One boiler, 6 ft. x 18 ft., built in 1900	1,100 00	
Two small pumps, 1884-91	175 00	
Underground steam piping, laid 1882	657 50	
Miscellaneous stock	119 75	
One water purifier	352 00	
One water meter	25 00	
Injectors	32 00	
Main steam pipe	155 00	
Safety valve on water main	35 00	
One pile hammer	10 00	
Six service boxes, in place 1893	8 10	
Six lawn hydrants, in place 1894	16 00	
Five-inch exhaust head	15 00	
Three fire hydrants, 1898	18 00	
1,200 ft. 3-inch iron water main, 1898	360 00	
Steel benching, put in in 1895	265 00	
College hall steam main, 1898	1,500 00	
Agricultural laboratory steam line, 1897	1,000 00	
2 L. & D. boiler feed pumps	260 00	
2 Kokomo telephones	28 00	
1 electric line and cons. to Williams hall tank	3 00	
One Worthington feed pump	28 00	
One fire whistle	20 00	
2 oil tanks	12 00	
5 steam gauges	4 00	
Steam lines, 1900	700 00	
Sewer line, 1900	600 00	
Miscellaneous tools	256 05	
One pressure gauge	35 00	
		15,911 40
Mechanical Department—		
Class room and office equipment	$8,348 96	
Machine shop	8,492 12	
Wood shop	2,792 33	
Blacksmith shop and foundry	1,855 62	
		21,489 03
Horticultural Department—		
Tools	$1,118 48	
Animals in Zoo	280 00	
Office and class room equipment	943 25	
Laboratory	81 50	
Teams, harness, etc	487 15	
Compost and manure	300 00	
Greenhouse plants	2,227 53	
		5,457 91
Amount carried forward		$452,190 84

Amount brought forward		$452,190 84
Mathematical Department—		
Surveying instruments	$2,562 09	
Photographic material	46 40	
Tools and apparatus	497 34	
Office furniture	311 07	
Class room equipment	561 80	
Astronomical	839 75	
		4,818 45
Botanical Department—		
Herbarium	$8,393 82	
Museum	900 75	
Tools	45 70	
Microscopes and accessories	1,342 65	
Glassware, chemicals, etc.	486 00	
Office equipment, etc.	1,280 52	
Books	200 95	
Class room furniture	358 70	
		13,009 09
Farm Department—		
Permanent fixtures	$1,140 26	
Tools and implements	1,744 50	
Field crops	956 40	
Office	500 25	
Stock	10,488 50	
Dairy	1,019 60	
Books	1,319 30	
Feed	602 69	
Wood	143 48	
Miscellaneous	95 50	
		18,010 48
Women's Department—		
Cooking school	$369 70	
Domestic science department	274 98	
Sewing room	330 22	
Wood carving room	373 58	
Music rooms	1,017 00	
Library	100 62	
Furniture, bedding, etc.	3,148 52	
Kitchen	248 23	
Dining room	580 86	
Laundry	59 14	
		6,502 85
Library—		
21,089 bound books	$39,744 00	
Pamphlets	170 00	
Portraits, etc.	2,066 05	
		41,980 05
Chemical Department—Furniture, apparatus and chemicals		12,355 35
Physical Department—Fixtures and apparatus		6,889 08
Veterinary Department—Museum, furniture and apparatus		1,691 00
Zoological Department—Furniture and apparatus		1,937 00
General Museum—Collections and cases		17,853 75.
History and Economics Department		144 00
Bacteriological Department		1,956 92
Drawing		1,793 18
Public Parlor—Furniture		50 80
Hospital—furniture		163 25
English Department		241 75
Amount carried forward		$581,587 74

Amount brought forward	$581,587	74
Farmers' Institutes	691	75
President's Office	720	28
Secretary's Office	1,792	72
Armory—Furniture and equipment	689	90
State Board of Agriculture rooms	411	69
Athletic Department	600	60
Chapel	295	25
Electric light plant	2,034	00
Furniture in post office	70	25
Miscellaneous furniture	428	00
Carpenter shop equipment	500	00
Lumber in stock	1,500	00
Michigan Weather Service	1,881	00
One dynamo agricultural laboratory	280	00
U. S. property held in trust—rifles and equipments	6,072	10
Total	$599,455	28

SUMMARY OF EXPERIMENT STATION INVENTORY.

Lands donated to the Station—		
80 acres at Grayling, fenced and improved at cost	$1,000 00	
5 acres at South Haven, fenced and improved	1,000 00	
160 acres at Chatham, including buildings	4,000 00	
		$6,000 00
Buildings—		
Experiment feed barn	$800 00	
Horticultural laboratory, experimental rooms	1,200 00	
Veterinary laboratory, experimental rooms	250 00	
Apiary	600 00	
Forcing houses, $1,500—$600.00	2,100 00	
Feed mill	100 00	
Sub faculty building	3,000 00	
Seed room	980 00	
Poultry house and yards	625 00	
Dairy room in agricultural laboratory	250 00	
Storage barn	600 00	
Cold storage fruit house	1,500 00	
		12,005 00
Horticultural Department—		
Spraying apparatus, etc	$103 25	
Office furniture	707 70	
Tools at South Haven	137 45	
		948 40
Farm Department—		
Tools, etc.	$835 00	
Dairy	272 00	
Office	457 75	
		1,564 75
Chemical Department—		
Apparatus	$1,468 90	
Glassware	111 65	
Porcelain	28 46	
Furniture and fixtures	147 10	
Miscellaneous	101 95	
Chemicals	100 37	
		1,958 43
Library—		
1,987 bound volumes	$3,637 00	
Accession book shelf list, etc	10 00	
Bulletin case, large	12 50	
48 bulletin cases	36 00	
Pamphlets	43 00	
		3,401 50
Bacteriological Department—		
Apparatus	$2,123 28	
Chemicals	393 08	
		2,516 36
Entomological Department—Microscopes, cases, etc		749 44
Upper Peninsula Station		350 78
Secretary's Office—Furniture, mailing list in type		450 00
Total		$29,944 66

DEPARTMENT REPORTS.

REPORT OF THE PRESIDENT.

Honorable State Board of Agriculture:

I beg to present to you my report for the year ending June 30, 1902.

The year has been a very prosperous one. Earnestness and industry have characterized the work in all departments. A greater number of students have been in attendance than ever before. During the earlier history of the College many students entered who had no interest in the technical training given. They desired a general education and entered this institution because they could earn a large part of their expenses. In later years very few students enroll who do not enter the institution because of a desire to receive the technical training given here. The spirit of the class room is thoroughly in harmony with the purposes of the College. The awakened interest in technical training both among farmers and mechanics indicates that in the future the equipment of the College must expand rapidly to meet the demands made by the increase in attendance.

BUILDINGS.

The Board, realizing the important part which bacteriology must play in agricultural education and experimentation in the future, decided to erect a building devoted to this subject. The second story of the veterinary building has for the past five years been used as a bacteriological laboratory. With the increased attendance it became entirely inadequate, and every attempt made to accommodate students in this low and ill ventilated room was attended with considerable risk.

The new building is a beautiful brick structure 59 by 76 feet, two stories high with well lighted basement. When completed and furnished the cost will amount to about $30,000. It will be one of the best of its kind in the country.

It is the intention of the Board to begin at once the erection of a fine bath house for young men. The old bath house is totally unfit for use. The 275 young men in our dormitories and more than 100 others living near the College grounds are sorely in need of such accommodations as this new bath house will give.

It is hoped that we may begin soon the installation of a new heating and lighting system. The old system is inadequate and affords but little protection from fire.

As the demands for room in several departments is very great, it has been a difficult matter to know what to build first. It is, however, very much desired that the College cease the erection of cheap buildings to meet simply present demand. We have already entirely too many buildings of this class. The institution has reached that period in its development where only buildings of a substantial character should be erected. The size also should be such as to allow for future growth.

CURRICULUM.

The only important changes made in the curriculum during the past year was the addition of a fifth year to the agricultural and women's courses. This places our four year courses on the same plane with the courses leading to the B. S. degree given by other good institutions. A state law compels us to admit students from the eighth grade. Hereafter such students will be required to spend five years at the College in order to receive the B. S. degree. Graduates of good four year high school courses will complete the course in four years.

It has been decided to add a department of forestry. It is the intention to offer a good four year course in this subject and to begin work with the opening of the next school year.

The largest class in the history of the College was graduated June 20. The baccalaureate sermon was delivered by the Rev. Camden M. Cobern, D. D., of Chicago. The commencement address was made by President W. O. Thompson of the Ohio State University.

The class numbered 59 and were as follows:

O. L. Ayrs
J. Fred Baker
E. R. Bennett
Elma M. Bowerman
H. L. Brunger
D. S. Bullock
E. Winifred Cannell
Frank G. Carpenter
Lyman J. Carrier
Albert H. Case
Ralph W. Case
Robert L. Cork
Guy S. Covell
A. G. Craig
Mamie Crosby
Matt Crosby
E. I. Dail
Clare Dean
H. G. Driskel
J. A. Dunford
Harriet A. Farrand
F. C. Fox
George D. Francisco
Mina B. Fuller
Warren J. Geib
Irving Gingrich
Harry Henderson
Norman B. Horton
David A. Keeler
H. S. Kneeland
A. E. Kocher
Wm. Krieger
O. F. Meade
Clark W. Millspaugh
Marguerite Nolan
Floyd W. Owen
W. S. Palmer
H. K. Patriarche
Burt A. Peterson
T. G. Phillips
John M. Rankin
E. A. Richmond
L. D. Rudolph
Mabel Severance
E. D. Searing
Ward R. Shedd
O. H. Skinner
Frances Sly
Dennis W. Smith
M. B. Stevens
George W. Stroebel
W. F. Uhl
Gertrude L. VanLoo
Clara Waterman
Burt Wermuth
William B. Willson
W. K. Wonders
W. R. Wright
H. Earl Young

The degree of Master of Science, in course, was conferred upon the following: Prof. J. D. Towar, '85; Prof. L. A. Clinton, '89, and Prof. F. E. West, '99.

I herewith submit a summary of students in attendance during the past year and also statistics referring to the entering class of last September:

Summary of students.

Summary.	Sugar beet.	Cheese.	Live stock.	Creamery.	Fruit.	Agricultural.	Mechanical.	Women's.	Totals.
Postgraduates						7			7
Class of '02						30	20	11	61
Class of '03						38	44	12	94
Class of '04						48	34	23	105
Class of '05						67	78	92	237
Sub-freshmen							72		72
Special students						9	1	20	30
Special short course students	25	16	24	24	5	94			94
Totals						293	249	158	700
Deduct names repeated									11
Final total									689

Class entering September, 1901.

	Male.	Female.	Total.
Number entering	178	93	271
	yrs. mo.	yrs. mo.	
Average age	20	19 4$\frac{1}{3}$	
Median age	19	19	
SCHOOLS PREVIOUSLY ATTENDED:			
High school	127	68	195
District	22	12	34
College	28	8	36
Private	1	5	6
ENTERED FRESHMAN CLASS ON:			
High school diploma	46	31	77
Teacher's certificate	13	10	23
Standing from other colleges	8	....	8
Examination	35	10	45
Age	40	11	51
Eighth grade diploma	36	31	67
SUPPORT WHILE HERE:			
Father	83	60	143
Self	58	14	72
Father and self	15	1	16
Mother	5	3	8
Not given	13	6	19
Guardian	4	9	13
OCCUPATION OF FATHER:			
Farmer	67	44	111
Mechanic	3	2	5
Doctor	1	2	3
Dentist	1	....	1
Veterinary	1	....	1
Lawyer	5	2	7
Clerk	2	1	3
Real estate	6	2	8
Lumber	1	2	3
Minister	4	1	5
Merchant	12	4	16
Manufacturer	4	3	7
Traveling man	6	2	8
Civil engineer	1	1	2
Commission man	2	....	2
College professor	1	....	1
Contractor	2	1	3
School teacher	2	2	4
Hotel keeper	1	....	1
Banker	1	2	3
Barber	....	1	1
Druggist	3	1	4
Deceased	5	5	10
Miscellaneous	30	10	40
Not given	17	5	22
PROPOSED OCCUPATION AFTER LEAVING COLLEGE:			
Farming	18	....	18
Mechanical engineering	16	....	16
Electrical engineering	8	....	8
Mechanic	10	....	10
Civil engineering	10	....	10
Chemist	2	....	2
Teaching	4	26	30
Law	1	....	1
Dressmaking	....	1	1
Housekeeper	....	2	2
Miscellaneous	19	2	21
Not fully decided	43	18	61
Not given	47	44	91

Church membership.

	Preference but not membership.	Membership.
Methodist Episcopal	25	25
Congregational	34	17
Presbyterian	19	16
Baptist	13	19
Episcopal	7	18
Lutheran	3	2
Catholic	2	6
Church of Christ	1	2
United Brethren	1	1
Universalist	5	3
Unitarian	1	1
German Evangelical	1	1
Dutch Reformed		1
No preference	47	

Counties represented in the entry class.

Allegan	1
Antrim	1
Barry	7
Bay	6
Benzie	1
Berrien	6
Branch	5
Calhoun	7
Cass	2
Charlevoix	1
Clinton	5
Eaton	7
Emmet	7
Genesee	8
Grand Traverse	2
Hillsdale	4
Houghton	3
Ingham	49
Ionia	10
Iosco	3
Jackson	7
Kalamazoo	7
Kent	6
Lapeer	5
Leelanau	1
Lenawee	8
Livingston	4
Mackinac	1
Macomb	4
Manistee	2
Marquette	3
Mason	5
Midland	1
Missaukee	1
Montcalm	3
Muskegon	2
Newaygo	1
Oakland	7
Oceana	2
Ottawa	5
Presque Isle	1
Saginaw	5
St. Clair	8
Sanilac	1
Shiawassee	3
Tuscola	5
Van Buren	7
Washtenaw	2
Wayne	17
Huron	1
	1

Other states and countries represented.

Pennsylvania	3
District of Columbia	1
Illinois	1
New York	6
Ontario Province, Canada	1
Porto Rico	1
California	2
Indiana	1

Respectfully submitted,
J. L. SNYDER,
President.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

For further information concerning the work of the College you are respectfully referred to the department reports contained in the following pages:

REPORT OF DEPARTMENT OF PRACTICAL AGRICULTURE.

President J. L. Snyder:

Dear Sir—I have the honor to submit the following report for the Department of Practical Agriculture:

In September last, Professor H. W. Mumford, then head of this department, resigned to accept a position at the University of Illinois. His resignation took effect Sept. 15, 1901, since which time the department has been temporarily in charge of the Assistant Professor of Agriculture.

Mr. J. J. Ferguson who has been on the department force since September, 1899, has been in direct charge of the instructional and practical work in live stock.

Mr. Geo. C. Humphrey and Mr. Geo. Severance have filled most acceptably the positions respectively of Instructor in Animal Husbandry and Instructor in Agriculture. The latter position was created at the beginning of the year.

The quality of instructional work we believe has been well sustained during the year, which fact is attested by the interest shown by the student body along all the lines of the work of the department. The results obtained by some of our seniors in some feeding experiments with lambs and cattle are of marked value and while done under the supervision of Mr. Ferguson speak very highly for the students.

During the first week of June took place the student stock judging contest for the Boland prizes. These were offered through the generosity of Mr. W. A. Boland of Grass Lake, Mich., who in 1901 made the department a donation of $100 to be used in two equal amounts of $50, one amount in 1901 and one in 1902, the $50 in each case to be divided into five sets of prizes of $5, $3 and $2 to be given for the first, second and third best judging of beef cattle, dairy cattle, horses, sheep and swine. The results of these contests have been very satisfactory both from the standpoint of the student and that of the department. Doubtless in the near future we shall take steps to establish a permanent fund for prize work.

At the fat stock show in 1901 M. A. C. did very creditable work, both in the student contest and in the show of stock, taking three first, two second and three third prizes from the Exposition for live stock and two first and one third specials from associations. One of these was the grand championship for dressed carcasses taken by Elm Park Lad, a registered Aberdeen Angus steer shown by M. A. C. against forty-nine competitors presented by other colleges and stations and leading breeders and feeders of the entire country.

The call upon us for men to enter both practical and technical fields of soils, crops, live stock and dairying, is such that we have not students sufficient to supply the demand.

The call and the need for a better knowledge in soils and crops were never so great as now. The principles underlying the production of live stock are appreciated and are being put into operation by a large and continually increasing number of farmers. The principles underlying the production of farm crops although equally important, are only slightly known and less appreciated by the tillers of the soil. The yields in Michigan for the ten years ending 1899 for four of our principal crops are as follows:

	Least.	Largest.	Average.
	Bushels.	Bushels.	Bushels.
Corn	23.0	38.0	29.0
Wheat	8.0	20.8	14.68
Oats	23.9	34.0	28.66
Barley	16.4	25.2	21.83

These figures are taken from the year book of the U. S. Department of Agriculture in 1889.

The yields should have been from fifty to one hundred per cent higher, and doubtless would have been, had the producers a proper knowledge and had made proper application of the principles of crop production. The net profits would have been increased in greater ratio.

According to Farm Statistics of Michigan, 1900-01, issued from the office of the Secretary of State, the estimated value of nine of the principal crops grown in Michigan for that year, not including sugar beets, was $77,150,000, while the estimated value for the total live stock of the farms of the State, not including poultry, was only $56,601,569.

We have been none too lavish in our expenditures in the interests of instruction in live stock, but the relative money value of the annual product of crops as against the total value of live stock, which includes the reserve supply, show at once that the larger interests have been receiving by far the smaller support.

A number of our sister colleges are taking up this work along more intelligent lines. Some of them are at considerable expense in the matter of providing room, help and funds for the work, as indeed they must be. The results, however, justify the outlay. We should be keeping pace with these institutions. The time is ripe for it. The work should not be delayed. For this we need more room, means to secure and retain for unlimited time men whose special tastes and abilities run in this direction, and funds for general and special expenses.

The very excellent condition of the crops on the College Farm and the favorable comment made upon them by visitors and members of the College force who have traveled both east and west, are highly pleasing to the department. It stands out, too, as an object lesson that there is a better method of agriculture than that practiced by a great majority of our farmers.

The purchasing of a new team last October for which funds had been provided, and the selling of one of the old teams and the purchase of a new one to take its place, gave us four teams again. The ease with which our work has been accomplished this year and this without the hiring of outside help and in spite of the inclement late season, speak well for the investment.

During the year Mr. Ferguson has added a number of excellent individuals to our flocks and herds.

A considerable amount of milk is now being brought to our dairy by farmers. This gives us sufficient milk to give our students instruction in all the phases of dairy practice and at the same time gives to our patrons their skim milk for feeding purposes, a thing which most of them greatly appreciate.

Respectfully,
JOS. A. JEFFERY,
Assistant Professor of Agriculture.

REPORT OF THE DEPARTMENT OF HORTICULTURE AND LANDSCAPE GARDENING.

To the President:

Sir—Few changes have been made in the work of the department or in its working force from what was reported one year ago. Prof. U. P. Hedrick has acted as assistant professor of horticulture and has had charge of the teaching and much of the laboratory work; Thos. Gunson has performed the duties of instructor in floriculture and florist, and as such has had charge of the College conservatories; M. L. Dean, in addition to his duties as assistant in the horticultural work of the experiment station, has acted as gardener and has attended to the growing, harvesting and marketing of the vegetables and fruits that were raised either for illustration or experimental purposes; Henry Sherman has been foreman of the gardens and grounds and, besides looking after the work of the teams and men, has aided in supervising the work of the students.

In addition to the regular work of the department the men and teams have been occupied for a considerable portion of the time in work for other departments. They have hauled all of the coal for the new boiler house, greenhouses and members of the faculty; they have also hauled several car loads of lumber, tile, brick and other supplies used about the grounds. This spring a large amount of team-work was done for the contractor for the bacteriological laboratory.

THE ORCHARDS AND GARDENS.

The trees in the College orchards made a very satisfactory growth last year and most of the older ones gave a good crop of fruit. This was especially true of the pears and plums. Fair crops only were secured of cherries and apples. The new plantations of currants, gooseberries and raspberries, made in 1900 and 1901, are looking very well, and a good crop of fruit will be secured from the raspberries.

The weather during the early part of this year was quite favorable for garden operations and the students were able to get the crops in in a very satisfactory manner, but the weather was so cold and wet during May and June that in many cases the growth was quite slow. Very little damage from the frosts was apparent.

INSTITUTES AND SOCIETIES.

During the month of December, the writer attended three one-day institutes in Antrim county at Central Lake, Alden and Elmira. Prof. Hedrick was at a one-day meeting at Lowell, Kent county, and Mr. Dean attended a two-day meeting at Clare, Clare county.

At the meetings of the State Horticultural Society at Monroe, Fennville, Frankfort and Pontiac, Prof. Hedrick, Mr. Gunson and the writer have been in attendance and presented papers. Some ten of the senior class were at the Monroe meeting and in short talks gave the results of some of the investigations they had been making during the year. While at Monroe they visited the nurseries of Greening Bros. and I. E. Ilgenfritz Sons, and thus gained some insight into nursery practice on a large scale.

GROUNDS.

The weather during the past year has been unusually favorable for the lawns, shrubbery and flower beds, as, except for a few weeks during August, the rainfall has been ample to prevent any check to their growth, and the grass, which in many places where the soil is light, was nearly killed out by the dry summers from 1890 to 1897, has thickened up and formed a very good sod. During the winter, some 200 loads of manure were hauled from Lansing, to be used upon the lawns where most needed as soon as composted. The shrubbery planted in the borders during the last three years has made a satisfactory growth and serves to embellish the lawns.

During the fall and spring considerable additions were made to the shrubbery and the plantings of herbaceous perennials, and in several instances the beds that had previously been used for annuals were filled with perennials.

The oversight of the landscape work on the capitol grounds was continued. In the fall, several thousand tulips and hyacinths were planted for spring flowering, and gave good results, nearly every bulb growing, and the tulips gave large flowers, true to name. This spring a large number of shrubbery beds were laid out on the north, west and south sides of the building. About a thousand hardy shrubs were used for these beds and some four thousand bedding plants for those made last year and for filling in among the shrubs.

GREENHOUSES.

During the summer and early fall two additional houses were constructed to supplement the large range, one designed for roses being 19 feet wide and a carnation house with a width of 26 feet, the length of both being 53 feet. The posts are of two-inch wrought iron and the gutters are also of iron of the Hippard pattern. The roofs are of cypress of standard design, with 16 by 20-inch double strength glass. The rose house is built with the long slope to the south, while the carnation house has its long slope to the north, thus lessening the shade upon the roof of the rose house. Jennings' patent fixtures were used for the benches and purlins and in one house Evan's Challenge ventilating apparatus was used while the Hippard Standard construction was used in the other. The ventilating sash are hinged at the ridge in one house while in the other the hinges are at the bottom of the sash. From this it will be seen that in addition to their great value in the work of the department, the houses serve as a means of illustrating and comparing the various methods of greenhouse construction.

In the rose house one bench was constructed of brick with a tile bottom, but all of the others are ordinary wooden benches.

Just north of the rose house and with a northern exposure, a leanto propagating house, 23 by 7 feet, was erected. The building formerly used as a stable was moved to the west end of the new houses and fitted up as a workroom, for which it answers well. The work of constructing the houses was done by Mr. Gunson and some of the students who are making a specialty of horticulture.

The grapery, which was constructed some ten years ago from the better portions of the old houses which were taken down at that time, needs quite extensive repairs if it is to be kept in its present location, and from the fact that it is proposed to heat the greenhouses with steam from the central plant it is suggested that it will be better to take the grapery down and use the cypress lumber and sash that is in the side-hill forcing house for the construction of a greenhouse adjoining those built last year.

INSTRUCTION.

The class-room and much of the laboratory work has been under the charge of Prof. U. P. Hedrick, who makes the following report:

"During the fall term, the following classes with the number of students in each were taught: Agricultural juniors in pomology, 39; Women juniors in floriculture, 15; Agricultural juniors in laboratory work in pomology, 39; the agricultural seniors were given instruction in the Botanical department in physiological botany.

"The teaching in the winter term was as follows: Seniors to the number of 20 received instruction in the evolution of garden plants. A course in floriculture and vegetable gardening was given to 17 juniors. The winter term I also conducted a class in agricultural chemistry for short course students.

"In the spring term there were three regular classes, namely: A class of 76 sophomores, men and women, in vegetable gardening and plant propagation; a class of 27 juniors in landscape gardening, and 10 juniors formed a class in the spraying of plants. In addition to the regular classroom work 23 seniors reported to do work on their theses at such hours as could be found.

"Among the students taught in horticulture this year were three who came for a whole or part of the year for special work in the department, and three others, one a graduate of Harvard, one from the University of Ohio and one from this institution for postgraduate work. There has been a decided increase of students in this department over last year, and the work in all respects has been very pleasant and I trust profitable."

The practical and much of the theoretical instruction in floriculture has been given by Mr. Gunson, who reports as follows: "During the winter the numbers of students under my charge were, seniors in thesis work, 3; regular juniors who had elected horticulture, 10; specials, 4. The juniors for one-half of the time studied the history, habitat, name, scientific and common, and the economic and horticultural value of the principal ornamental greenhouse plants from living specimens. Each student was also required to draw a plan of a modern greenhouse structure, and to compute the amount of radiation required to maintain different temperatures both with steam and with hot water. On alternate days during the term special work was assigned them. Two had charge of watering, staking, picking and propagating carnations; two looked after the crop of violets; two propagated and potted geraniums, and as the season advanced attended to the sowing and pricking out of annual plants; two gave their attention to the care of the general greenhouse and ornamental plants and two others to the propagation of coniferous trees, hardy roses, flowering shrubs and other deciduous hardy plants. One of the special students confined his work to lettuce, another to carnations and two to violets.

"Nearly six weeks of the spring term was required by the seniors to complete their theses. The juniors continued in charge of the crops or special work assigned to them at the beginning of the winter term.

"In the fall term the juniors aided in the regular greenhouse work, such as making cuttings, potting plants and planting roses, violets and carnations on the greenhouse benches, and in the erection of the new greenhouses."

In the spring term the work carried on by the sophomores was much the same as in previous years, the practical portion being divided between the orchards, gardens and grounds. Several students aided in supervising the work of the various sections into which the class was divided. Among them were Chas. Johnson, a postgraduate, and E. R. Bennett, T. G. Phillips, W. K. Wonders, W. S. Palmer and O. L. Ayrs, members of the senior class, all of whom took much interest in the work and made very efficient instructors.

IMPROVEMENTS NEEDED.

Although the grounds now have a large amount of stone walks there are several places where other walks can be placed to advantage. One is between the library and the new dairy building; another is along the front of Abbot Hall to accommodate the large amount of travel between the street car station and faculty row, and the armory; a third place is from the east door of Wells Hall to connect with the main walk.

During the last ten years a considerable amount of shrubbery has been planted on the grounds, but it has been for the most part about the newer buildings, and many portions are still quite bare. The work should be continued until it has been completed.

Respectfully submitted,

L. R. TAFT,

Professor of Horticulture and Landscape Gardening and Superintendent of the Horticultural Department.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF THE DEPARTMENT OF MATHEMATICS AND CIVIL ENGINEERING.

To the President:

SIR—So far as this department is concerned the year past may be characterized as one of exceptional activity and of fairly satisfactory results. Student sentiment has never been better, and it is jointly due to this fact and to the zeal and adaptability of our instructors that so much has been accomplished under rather adverse circumstances. Changes in our teaching force contributed to our difficulties, and sickness among the students interfered with satisfactory progress of the classes to a greater extent this year than for many years before. Epidemics of mumps and measles kept very many students out of classes for weeks at a time.

Assistant Professor W. Babcock, Instructor L. L. Locke and Instructor A. H. Parrott have continued in their respective positions. Mr. Locke will leave us at the end of the year to accept a position in Adelphi college, Brooklyn, N. Y. Mr. S. E. Brasefield was appointed instructor for the year and served until the fifth week of the winter term, when he withdrew to take a position in Lafayette college. Upon his retirement a readjustment was made in the work of instruction and Mr. Paul Thayer, a postgraduate student, was employed as assistant for the rest of the term. At the beginning of the spring term Mr. A. T. Swift was appointed instructor and entered upon his duties, but upon being offered a desirable business position he requested that he be relieved. His resignation was accepted at the end of the fifth week of the spring term, and the work assigned to him was thereafter shared by Mr. R. L. Yates, a junior student of the college, and Mr. A. E. Kocher, a senior. The changes enumerated no doubt had the effect of somewhat lowering departmental efficiency, and therefore are to be regretted. They are probably penalties we suffer for being overbid in the market for teachers.

At their first meeting for the fall term the faculty considered my recommendation of last year's report that some civil engineering studies be added to the mechanical course as options. The matter was referred to a committee of five, who reported to the faculty Nov. 4, 1901, recommending a schedule of options which was approved by the faculty, and later, Dec. 4, 1901, was adopted by the Board of Agriculture. The studies added to our curriculum by this action include topographical drawing and sketching, shades, shadows and perspective, railroad surveying, bridge analysis and design, masonry, arches and pavements. Seventeen members of the junior class decided to elect this optional course and entered upon the work as outlined.

The following text-books have been used in our classes during the year: Beman & Smith's Higher Arithmetic by the classes in mensuration; Wells' Essentials of Algebra by the women and agricultural students; Hall & Knight's College Algebra (Sevenoak's revision) by mechanical students; Wentworth's Geometry by women and agricultural students; Phillips & Fisher's Geometry (abridged) by mechanical students in the fall term; Wells' Essentials of Geometry by mechanical students in the spring term; Jones' Trigonometry; Tanner & Allen's Analytic Geometry; Taylor's Calculus; Hodgman's Surveying; Johnson's Surveying for all classes in higher surveying; Church's Mechanics; Merriman & Jacoby's Graphic Statics. A comparison of this list with last year's will show that we have made only one change of text during the year.

The assignments of our teachers to class work, the number of students enrolled, etc., are shown by the following tabulation.

Class work of the department of mathematics and civil engineering for the college year 1901–02.

Class.	Subject.	Number of course.	Teacher.	Class room.	Hour of meeting.	No. of hours per week.	No. students in class.
Fall term:							
Sub-freshmen	M. algebra	Math. 1c.	Mr. Brasefield	Abbot Hall	8-9	5	38
"	M. "	" "	" "	" "	9-10	5	33
Freshmen	Ag. & W. algebra	" 1a.	" "	8, College Hall	10-11	5	16
"	Ag. & W. "	" "	Mr. Locke	8, " "	8-9	5	32
"	Ag. & W. "	" "	" "	8, " "	9-10	5	22
"	Ag. & W. "	" "	Mr. Parrott	Dairy	11-12	5	22
"	M. algebra	" 1e.	Prof. Babcock	6, College Hall	10-11	5	30
"	M. "	" "	" "	6, " "	2-3	5	27
"	M. "	" "	Mr. Parrott	6, " "	1-2	5	29
"	M. geometry	" 2d.	" "	2, " "	8-9	5	17
"	M. "	" "	Mr. Brasefield	8, " "	11-12	5	26
"	M. "	" "	Mr. Locke	8, " "	1-2	5	22
"	M. "	" "	" "	8, " "	2-3	5	19
Sophomores	Ag. geometry	" 2b.	Mr. Parrott	2, " "	9-10	5	20
"	Ag. "	" "	" "	Dairy	10-11	5	23
"	Analytic geom	" 5.	Prof. Babcock	6, College Hall	8-9	5	23
"	" "	" "	" "	6, " "	9-10	5	18
Juniors	Integral calculus	" 6b.	" "	6, " "	11-12	5	21
"	" "	" "	Mr. Locke	Abbot Hall	11-12	5	20
"	Surveying (class)	Civ. Eng. 1b.	Prof. Vedder	2, College Hall	10-11	2	42
"	" (field)	" "	Prof. Vedder and Mr. Brasefield		2-4	2	20
"	" "	" "			2-4	2	22
Seniors	Graphic statics	" 4.	Prof. Vedder	2, College Hall	11-12	3	21
"	Ag. C. E. (class)	" 2.	" "	2, " "	3-4	5	7
"	" " (field)	" "	" "		8	2½	7
Totals	25 Sections					111½	577
Winter term:							
Sub-freshmen	M. algebra	Math. 1d.	Mr. Locke	Abbot Hall	8-9	5	32
"	M. "	" "	Mr. Parrott	" "	9-10	5	28
Freshmen	W. "	" 1b.	" "	6, College Hall	1-2	5	23
"	W. "	" "	Mr. Thayer	8, " "	10-11	5	20
"	Ag. "	" "	" "	6, " "	2-3	5	26
"	Ag. "	" "	Mr. Parrott	Abbot Hall	10-11	5	30
"	M. "	" 1f.	" "	" "	11-12	5	23
"	M. "	" "	Prof. Babcock	6, College Hall	11-12	5	23
"	M. "	" "	Mr. Locke	8, " "	11-12	5	21
Sophomores	Dif. calculus	" 6a.	Prof. Babcock	6, " "	10-11	5	19
"	" "	" "	Mr. Locke	2, " "	10-11	5	21
Juniors	Mech. of Eng	" 7a.	Prof. Vedder	2, " "	8-9	5	18
"	" "	" "	Prof. Babcock	6, " "	8-9	5	16
Seniors	Ag. eng'g	Civ. Eng. 3.	Prof. Vedder	2, " "	9-10	5	6
"	Hydraulics (class)	" " 5.	" "	2, " "	11-12	5	11
"	" (lab.)	" " "	" "	2, " "	1-5	4	11
Totals	16 Sections					79	328

Class work—Continued.

Class.	Subject.	Number of course.	Teacher.	Class room.	Hour of meeting.	No. of hours per week.	No. students in class.
Spring term:							
Sub-freshmen..	M. geometry.....	Math. 2c.	Mr. Yates......	8, College Hall	11-12	5	27
" ..	M. "	" "	" "	8, " "	2-3	5	17
" ..	Mensuration.....	" 3.	" "	8, " "	3-4	5	18
" .	"	" "	Mr. Locke......	Abbot Hall..	10-11	5	28
Freshmen......	W. geometry....	" 2a.	Mr. Kocher....	8, College Hall	8-9	5	25
"	Ag. "	" "	" "	8, " "	9-10	5	27
"	Ag. "	" "	Mr. Parrott....	6, " "	3-4	5	21
"	M. trigometry....	" 4b.	Prof. Babcock.	6, " "	11-12	5	21
"	M. "	" "	Mr. Locke......	Abbot Hall..	11-12	5	18
"	M. "	" "	Mr. Parrott....	2, College Hall	11-12	5	20
Sophomores....	Ag. pl. trig.......	" 4a.	Prof. Babcock.	2, " "	8-9	3	23
"	" "	" "	Mr. Parrott....	8, " "	10-11	3	15
"	Ag. surv'g (class)	Civ. Eng. 1a.	Prof. Babcock.	2, " "	8-9	2	31
"	Ag. " (field)..	" "	Profs. Vedder and Babcock.	....	1-3	2	17
"	Ag. " " ..	" "			1-3	2	14
"	Integral calculus	Math. 6b	Mr. Locke......	6, College Hall	8-9	5	18
"	" "	" "	Mr. Parrott....	Abbot Hall..	8-9	5	16
"	W. geometry.....	" 2b	Mr. Locke......	6, College Hall	9-10	5	16
Juniors.........	H. surv'g (class)..	Civ. Eng. 6.	Prof. Vedder...	2, " "	9-10	3	20
"	H. " (field)..	" "	Profs. Vedder, Babcock, and Mr. Locke	....	1-4	6	20
"	Mech. of eng.....	Math. 7b.	Prof. Vedder...	2, College Hall	10-11	5	18
"	" "	" "	Prof. Babcock.	6, " "	10-11	5	14
Seniors.........	H. surv'g (class)..	Civ. Eng. 6.	Prof. Vedder...	2, " "	9-10	3	16
"	H. " (field)..	" "	Profs. Vedder, Babcock and Mr. Locke	....	1-4	6	16
Totals.........	24 sections.......	....	....	....	....	105	476
Grand totals....	65 sections.......	....	....	....	....	295½	1381

Besides the work indicated in the above tabulation, which includes all the regularly scheduled classes, we have directed the instruction of several special classes taking lettering and topographical drawing.

The main additions to our instrumental equipment include an electric current meter, a dissected transit for class illustration, several tapes and chains, three slide rules and ten ranging poles. We have purchased a number of smaller items, also a few small tools needed in making repairs. We need larger appropriations for the purchase of more transits and levels, and for keeping all our instruments in good working order. There have been provided for the department office a new roller copier, a duplicating apparatus, a type-writer, and the stationery necessary for the year's business. The total expenditure by the department during the year for all purposes is $527.42, of which $149 was turned in by the department for special examination fees.

The inventory of department property, including instrumental equipment, class-room and office furniture, observatory apparatus and tools shows an aggregate of $4,818.45 on June 30, 1902, as against $4,536.53 last year.

Respectfully submitted,
H. K. VEDDER,
Professor of Mathematics and Civil Engineering.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF THE MECHANICAL DEPARTMENT.

To the President:

Sir—I have the honor of submitting the following report of the work done in the Mechanical Department during the year ending June 30th, 1902.

The work in the class rooms, drawing rooms, etc., has been conducted as follows:

FALL TERM.

Seniors.—Thermodynamics and Graphical Statics of Mechanism by Prof. Weil. Steam Engine Design and Experimental Laboratory by Mr. Reynolds. Elementary Kinematics by Mr. Wells. Shop Practice by Mr. Leonard.

Juniors.—Machine Design by Mr. Wells. Shop Practice by Mr. Leonard. Metallurgy by Prof. Weil.

Sophomores.—Shop Methods by Mr. Leonard. Shop Practice by Messrs. Leonard, Theadore and Baker.

Freshmen.—Shop Practice by Mr. Bradford and Mr. Baker.

Sub-Freshmen.—Visits of Inspection by Mr. Wells.

WINTER TERM.

Seniors.—Advanced Kinematics by Prof. Weil. Steam Engineering Laboratory by Prof. Weil and Mr. Reynolds. Advanced Machine Design by Mr. Leonard.

Juniors.—Machine Design and Steam Engine Design by Mr. Wells. Valve Gears and Boilers by Mr. Reynolds. Shop Practice by Mr. Leonard and Mr. Theadore.

Sophomores.—Elements of Machine Design by Mr. Wells. Shop Practice by Messrs. Leonard, Theadore and Baker.

Freshmen.—Shop Practice by Mr. Bradford and Mr. Baker.

Agricultural Freshmen.—Shop Practice by Messrs. Theadore, Bradford and Baker.

SPRING TERM.

Seniors.—Engineering Practice by Prof. Weil. Thesis Work by Prof. Weil and Mr. Reynolds. Original Design by Mr. Leonard.

Juniors.—Strength of Materials by Mr. Wells. Testing Materials of Engineering by Mr. Reynolds. Shop Practice by Mr. Leonard and Mr. Theadore.

Sophomores.—Elements of Machine Design by Mr. Wells. Elements of Steam Engine by Mr. Reynolds. Shop Practice by Messrs. Leonard, Theadore and Baker.

Freshmen.—Shop Practice by Mr. Bradford and Mr. Baker.

At the close of the College year, Professor Hugo Diemer resigned his position to accept a position in practice. At this time Mr. H. W. Reynolds of the department was promoted to the position of senior instructor and Mr. W. W. Wells, of the class of 1901, elected junior instructor, in mechanical engineering.

On account of the large attendance during the year Mr. Theadore has been employed to give instruction in the machine shop as well as in the forge shop; also, several young men have been employed in the shop as general assistants,—thus facilitating the work of the department.

Because of the crowded condition of our shops, of late, but a limited amount of time can be spent on regular machine building, but during the year considerable progress has been made along this line. The latest important addition, of our own manufacture, to our equipment is an arbor press.

This department now has complete sets of designs and working drawings for a number of machine tools, including milling machine, drill press, engine, lathe, shaper and arbor press.

During the year the usual amount of repair work has been done and, as in the past, the shops will run for similar work a part of the summer vacation.

Among the more important apparatus added to this department, during the year, I will mention the following: Diamond morticer, 4 H. P. gasoline engine, 5 H. P. electric motor, blower, three steam engine indicators, portable volt meter, portable ameter, 24 high grade thermometers, shrinkage test apparatus, standard lubricator, master square, planimeter, camera, four drawing tables, three speed indicators. Also have purchased various gear cutters and hobs and numerous small tools for the shops.

We are pleased to note the authorization, by our Board, of the construction of a new engineering building.

We feel that a satisfactory interest has been displayed by our students and engineering concerns in the work of the department during the year.

During the winter and spring the writer did considerable work as consulting engineer for the College on plans for heating, lighting and water systems.

Respectfully submitted,
CHAS. L. WEIL,
Professor of Mechanical Engineering.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF THE DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY.

To the President:

SIR—I have the honor to submit the following report of the Department of Zoology and Physiology for the year ending June 30, 1902:

The schedule of classes for the year was as follows:

Fall Term.—Economic Zoology for senior agriculturals and women, elective, 30 students. Anatomy and Physiology for sophomore agriculturals, required, 47 students. Anatomy and Physiology for sophomore women, required, 40 students. Total for term, 117 students.

Winter Term.—Geology for senior agriculturals, elective, 23 students. Geology for senior women, elective, 4 students. Anatomy and Physiology for sophomore agriculturals, required, 40 students. Anatomy and Physiology for sophomore women, required, 30 students. Physical Geography for sub-freshman 5-year mechanicals, required, 62 students. Entomology for fruit course specials, 6 students. Total for term, 165 students.

Spring Term.—Entomology for senior agriculturals, elective, 13 students, Entomology for junior horticulturals (horticulture 6a), 10 students. Entomology for sophomore agriculturals, required, 40 students. Total for term, 63 students. Total number of students for the year, 345.

TEACHING FORCE AND EQUIPMENT.

At the close of last year Mr. William T. Shaw, instructor in zoology, resigned in order to accept a position in the Iowa Agricultural College, and his place was filled by the election of Mr. Jesse J. Myers, a graduate of the University of Illinois, who came well recommended and has justified all that was said of him. Mr. Myers gives his whole time to the work of this department; Mr. R. H. Pettit, instructor in zoology, has continued to give about half his time to this work, the remainder being given to entomological work for the Experiment Station. Thus for the first time in eight years the force of the department has been fairly sufficient for the work expected of it. The class work has never been so satisfactory as during the past year, and it has been possible, moreover, to carry out some needed improvements in the laboratory and museum. The entire supply of anatomical and zoological teaching material has been overhauled, sorted and arranged for convenient reference, while some of the gaps in the illustrative series in the museum have been filled. Numerous lantern slides have been prepared as well as a large number of microscopic mounts for the laboratory classes. In addition to the regular classes instruction has been given to a few students in taxidermy and methods of preserving specimens, but such work has been entirely voluntary on the part of the students and the number necessarily has been small.

COLLEGE EXTENSION WORK.

In the way of College Extension Work the Department has not been idle. Besides answering hundreds of letters from farmers, school teachers and others in regard to all manner of things biological and geological, the writer has given several addresses on scientific subjects during the year, and Instructor Pettit was assigned to duty on farmers' institutes for two weeks during the fall term. The press of class work during the winter term makes it impracticable for any member of the force to do regular institute work.

INSECT COLLECTIONS FOR THE COMMON SCHOOLS.

For several years it has seemed to us that the College might do more than it has done to stimulate interest in nature study in the common schools of the State, and in view of the remarkable increase of interest in such lines recently it was determined to attempt something practical in the line of insect study. The State Board of Agriculture supplied the funds for the preparation of 50 cases for insects, and the Department has undertaken to fill these cases and place one in each high school in the State, accompanied by a pamphlet descriptive of the insects contained in each collection. During the summer vacation more than seven thousand insects were collected and prepared, and as soon as the cases were available all spare time was devoted to preparing the collections. Up to the present time twenty-four high schools have been supplied and twenty-five more cases will be sent out early in the fall. Other cases will be made as soon as possible, and it is hoped that each high school in the State may be supplied before the close of the year. Each collection contains about 75 specimens of the more common and interesting insects of the State, clearly labeled with both common and scientific names, and numbered for reference to the accompanying pamphlet which contains notes on each species represented. The specimens have been carefully selected so as to illustrate all the important orders of insects, as well as many of the interesting facts of insect life, such as larval and adult forms, protective coloration, mimicry, beneficial and harmful species, etc. Each case is of polished cherry with plate glass front, and is intended to hang on the wall of the schoolroom, but can be laid flat on the table for careful examination. As it is very shallow the insects are close enough to the glass to allow of examination with a reading glass or a low power magnifier without removing the cover.

These collections have been enthusiastically received by the schools thus far provided and it is evident that they will be useful to the schools in many ways, while at the same time they will serve to bring the College in closer touch with the schools. The actual cost of this experiment is slight compared with the good which is sure to be accomplished; it is only to be regretted that the plan cannot be enlarged so as to include the smaller schools as well as the larger.

BIRDS OF MICHIGAN.

Another matter which has received considerable attention during the year is the bulletin on the birds of the State, for which there is an increasing demand. Work on this has been pushed as rapidly as possible but several things have conspired to delay its completion. The former bulletin, published in 1893 by Professor Cook was necessarily deficient in information as to the birds of the Upper Peninsula as well as several large sections of the Lower Peninsula. Much more complete information is desirable also on the breeding range, migrations, and economic relations of many of our commonest species. Members of the Michigan Ornithological Club and the Michigan Academy of Science were asked to cooperate in collecting these data and much valuable help has been given by members of both these organizations. It is desirable, however, that considerable more field work should be done in some parts of the State by thorough ornithologists before the bulletin is completed. The writer spent a few days in Mackinac county last August and a few more in Otsego and Crawford counties in June, and both trips added important facts to our knowledge of the summer birds of those regions, but a thorough investigation of the animal life of the northern half of the State undoubtedly would yield most interesting and valuable results. It is to be hoped that the College, by itself or in cooperation with the State Geological Survey, may take up this matter and push it to a speedy completion. Its direct bearing upon agriculture in its broader sense, including forestry, is so obvious as to need no comment.

NESTING PLACES FOR COMMON BIRDS.

In the spring of 1899, under the direction of the State Board of Agriculture, I prepared and placed about the College campus about forty nesting boxes for wild birds, hoping in this way—and by the simultaneous warfare on the English Sparrow—to increase the number of valuable native birds about the grounds. Most of the boxes were intended for wrens and bluebirds but two large "martin-houses" were erected in the hope of attracting colonies of the purple martin and white breasted swallow. Owing to the objections of the superintendent of the grounds these latter bird-houses could not be placed in favorable places and thus far they have remained untenanted except by the ubiquitous sparrow. The number of wrens about the grounds has been very largely increased, however, at least a dozen pairs having established themselves this spring, most of which undoubtedly will rear second broods. Bluebirds have been steadily increasing in the vicinity of the College for the past four years—and probably throughout the whole State—but so far as I can discover not a single pair has actually nested in any one of the boxes which were specially provided. The sole cause of this does not lie with the English Sparrow, although a large part of the responsibility certainly may rest there. Both red squirrels and bluejays are extremely abundant on the campus and both are serious enemies of all our birds. The red squirrel in particular drives out the birds which nest in holes and boxes and not a few of the wooden boxes intended for wrens and bluebirds have been almost destroyed by the squirrels in their efforts to get at young birds or from wanton mischief. The whole subject of the birds of the campus is an interesting one and presents several problems which are now under investigation. The entire absence of many species which are common just outside the campus is certainly remarkable and no one of the factors already mentioned will alone account for that absence. A full report on this matter will be made at another time.

SANITARY PRECAUTIONS.

In August last, as you will remember, I called your attention to several matters which menaced the health of the community, with the request that they be brought before the State Board unless some remedy could be found more easily. One of the matters related to the restriction of the mosquito plague, the remedy for which I pointed out at that time. This matter has been taken up recently by the Board and I understand that some of my suggestions will be carried out although not under my supervision. It is to be hoped that whatever may be the results of this first attempt at mosquito extermination the matter will not be allowed to rest until the swamps in the immediate vicinity of the College have been drained or otherwise rendered innocuous as breeding places for this pest, and until the equally dangerous places on the campus itself have been abolished.

Another danger to which your attention was called, and which in my opinion is even more serious because its presence is not realized, lies in the ice supply for the College. So far as I know nothing has been done to lessen the danger from this source.

Ice cut from the Cedar river near the College is not fit for general use; it is not simply impure but often dangerously so. True, it is not *intended* for use in drinking water or other beverages, but it is so used in very many cases and it has been used in the dairy in ways that endanger the health of the community. It is not necessary to enumerate again the sources of pollution of the river from which the ice comes; suffice it to say that they are numerous and undeniable. Moreover, inquiry has shown that since building of the spur of the railroad into the College grounds it is possible to fill the College ice-house with comparatively pure ice, from Lake Odessa or some equally safe lake—at a very slight increase on the present cost, thus avoiding all danger from this source.

Respectfully,
WALTER B. BARROWS,
Professor of Zoology and Physiology.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF THE CURATOR OF THE GENERAL MUSEUM.

To the President:

Sir—I have the honor to make the following report of the condition of the General Museum for the past year:

There have been few changes of importance in the General Museum during the past twelve months and the greater part of the time spent upon it has been expended in keeping the specimens from deterioration and making the collections more attractive to the public and more useful to the students. The public appears to appreciate the opportunities of the Museum better each year and it has attracted several thousand more visitors than ever before. I regret to say that a small and thoughtless minority of these visitors has caused much annoyance by writing their names on the walls and even on some of the specimens in the Museum, and some have gone so far as to cut their initials or full names in the plaster casts which are outside the cases. During week days it has been feasible to watch the Museum with some care and such depredations have been largely prevented, but it became necessary to close the Museum to visitors on Sundays or else to employ an attendant to stay in the hall constantly while the doors were open. The former course was adopted for the present, but after the damage has been repaired I would recommend that the collections be thrown open to the public again on Sundays and that an attendant be employed to take charge of the Museum at such times. It is much to be regretted that the elephant skeleton, the very large cast of the *Elephas* tusks, and the cast of the *Glyptodon* cannot be placed under glass so that defacement would be impossible, but the room is so crowded already that no large cases can be added without still further impairing the appearance and utility of the collections. I might add that already we have been compelled to store away thousands of good specimens from lack of space in the cases, and even as it is most of the cases are so badly crowded that the visitor often gets only a confused idea of the objects represented.

This is true particularly of the cases of minerals and fossils, and of the reptiles and fishes; it would be easy to fill twice as many cases as we now have with the specimens necessarily stored away.

The valuation of the collections has not changed materially since last year, the inventory just finished giving a total valuation of $17,853.75. Very little money has been expended of late years in additions to the collections, as it has been my belief that such purchases ought to be confined mainly to materials which will be of direct and practical value to the College student. It is my belief that for this purpose nothing is more important than a full representation of the natural history of the State itself, and I have made every effort consistent with other duties to build up local collections which shall be measurably complete. Of course we never refuse donations of specimens from any part of the world, but it is far more important, in my opinion, that we should have in our Museum good specimens of every Michigan mammal, bird, reptile and fish than that we should have rare and strange specimens from other continents. It would be best of course to have *both*, but having neither space nor funds for extensive exhibits it seems wise to limit purchases—at least for the present—to such things as will illustrate the natural wealth of our own State.

The bird collection is already better than that in any other college in the State, with the exception of that in the University of Michigan. The collection of mammals is much smaller and not as good in proportion, but nevertheless is good. The display of reptiles is large but not good, the specimens are poorly prepared and ill displayed for lack of space.

The collection of fish is hardly worthy of the title, there are so few good specimens of our common fishes, either mounted or in alcohol. Some important additions have been made during the past two years but this section of the Museum remains far behind that of any other, and this is due only in part to the difficulty of *preserving* specimens properly, it is difficult to *get* good specimens to preserve.

The transfer of the specimens of the insect collection from cork to the unit system of wooden blocks has been almost completed during the year. About two hundred and twenty-five cases have been rearranged on the new system and only about a score of cases remain to be completed. In the course of this work very many new species have been interpolated, while new specimens have been added or put in place of faded or defective ones. As this collection of insects numbers several scores of thousands of specimens it will be seen that its care alone is an important part of the work of the department, and its rearrangement has been a labor of considerable magnitude. As at present constituted the collection is disappointing in one respect; very many species are represented only by specimens which bear no locality labels while many more are represented only by specimens taken outside the State. It is my wish and purpose to see every insect species which is found within our limits represented in our collection by specimens actually taken in the State. It will take many years to accomplish this, but a beginning has been made and each year sees hundreds of local specimens added and a gradual approach to the desired end.

Following this report will be found a complete list of the accessions to the General Museum for the past three years, that is, from July 1, 1899, to June 30, 1902. The list is arranged alphabetically by the names of the donors or parties from whom the specimens were obtained. The list does not include gifts of *insects*, which are too numerous each year to be listed.

Among the more important additions since the last report of accessions should be mentioned a fine Canada Lynx presented by Mr. Wm. M. Snell of Sault Ste. Marie, and beautifully mounted by the late Percy Selous of Greenville; fourteen mounted specimens of mammals, birds and fish from Mr. Selous' collection—all local specimens; and a collection of about two hundred skins of Michigan birds obtained from Mr. Leon J. Cole of Ann Arbor, a former student of this College.

Respectfully submitted,
WALTER B. BARROWS,
Curator of the General Museum.

LIST OF ACCESSIONS TO THE GENERAL MUSEUM FOR THE THREE YEARS ENDING JUNE 30, 1902.

Angell, Ira D.—Blue racer, *Bascanion constrictor.* M. A. C.

Baker, Dr. H. B.—Larval tape-worm, *Dibothrium,* from Shiawassee R., Chesaning, Mich.

Baker, Hugh.—Limestone from St. Croix Falls, Wis.

Banghart, Leonard.—Tarantula, centipede and 8 scorpions from Cuba. (Purchased.)

Barrows, W. Morton.—Turkey Buzzard, *Cathartes aura,* M. A. C.

Barrows, W. B.—Collection of turtles and fish from Pine Lake; swamp tree-frog, Ingham county; frogs and tortoises, M. A. C.; skulls of common mole and several species of birds.

Bartlett, N. D.—Red bat, *Atalapha noveboracensis,* from Parkdale, Mich.

Beal, Dr. W. J.—Scarlet tanager, *Piranga erythromelas;* corals, shells, sea-urchins, arrow-heads; red squirrel, partial albino; M. A. C.

Brotherton, W. A.—*Cristatella sp.* from Monroe Creek, Mich.

Brown, B. S.—100 arrow-heads and three stone axes, from Monterey, Mich. (Purchased.)

Bullock, D. S.—White-footed mouse, M. A. C.; red squirrel, *S. hudsonius*; marine shells from Gulf of Mexico; set of 5 eggs of least bittern, *Ardetta exilis.*

Butterfield, Hon. I. H.—About 25 specimens of native copper from Ontonagon, Mich.

Buskirk, Miss Bessie I.—Five specimens of Walkerite crystals from Pine Ridge Indian Agency, S. Dak.

Case, A. H.—Carboniferous fossils from Grand Ledge, Mich.

Church, Mrs. Chas. W.—Large nest of yellow-jacket from gable of house in Lansing.

Cole, Leon J.—Brook lampreys, *Lampetra wilderi,* from Dixboro, Mich.; collection of bird skins and eggs (200 skins). (Purchased.) 3 specimens of Pycnogonida from Woods Holl, Mass.; pair of Esquimaux boots from Alaska.

Coryell, R. J.—Skull of coyote, *Canis latrans,* from Belle Isle Park, Detroit.

Emery, Chas. S.—Adult tape-worm from fresh-water fish.

Forbes, Guy R.—Weasel, *Putorius noveboracensis,* Ingham county, Mich.

French, W. T.—Chain coral, *Halysites,* from drift, M. A. C.

Gingrich, Irving.—Salamander, *Plethodon erythronotus,* M. A. C.

Ginn & Company.—Set of three Harvard geographical models. (Purchased.)

Gladden, H. P.—Rock specimen, M. A. C.

Goodrich, Geo. G.—Fossil stem, "*Stigmaria,*" St. Charles, Mich.

Grinold, E. R.—Fossil shells from Petoskey, Mich.; cast of Indian pipe from Watertown, Mich.

Hagaman, A. P.—Golden eagle, *Aquila chrysaetos,* from Oakland county, Mich. (Purchased.)

Hastings, F. W.—Mound builder's pot or vase from Benzie county, Mich.

Hedrick, Prof. U. P.—Skull of muskrat, *Fiber zibethicus,* from Monroe, Mich.

Horticultural Dept.—Peacock, *Pavo cristatus;* antlers of elk.

Houghtaling, J. M.—Turkey Buzzard, *Cathartes aura,* from Riley Centre, Clinton county, Mich. (Purchased.)

Howell, Edwin E.—Relief map of the United States. (Purchased.)

Kedzie, Frank S.—Nodule containing fossil fish, locality unknown.

Kedzie, Dr. R. C.—Three arrow-heads, Isabella county, Mich.

Kendrick, J. L. S.—Vein in slate from Algoma county, Ont.

Kittle, Geo. D.—Barn owl, *Strix pratincola,* from Oneida (near Grand Ledge), Mich. (Purchased.)

Lane, Dr. A. C.—Brachiopods, *Lingula mytiloides,* from Bay City, Mich.

Lohman, George.—Souvenir metal plate from Spanish war-vessels; hair-worm, *Gordius sp.,* M. A. C.

Lyman, James H.—Celt or stone axe from Bancroft, Mich.

Martin, E. J.—Schistose rock, supposed to be fossil wood, from Grand Ledge, Mich.

Megiveron, Ira.—Bullfrogs from Park Lake. (Purchased.)

Megiveron, Wm.—Osprey, *Pandion carolinensis,* from Pine Lake, Mich.

Myers, J. J.—Various snakes, frogs, salamanders, M. A. C.

Newman, Chace.—Salamander, *Plethodon glutinosus.*

Norton, C. L.—Herring gull, *Larus argentatus smithsonianus,* from Pine Lake.

Pettit, R. H.—Collection of mammals, birds, reptiles, amphibians and mollusks from Chatham and Beaver Island, Mich.; winter wren, *Troglodytes hiemalis,* M. A. C.; skulls of porcupine, *Erethizon dorsatus,* and muskrat, *Fiber zibethicus.*

Rankin, John M.—Skull of Cotton-tail, *Lepus sylvaticus*; fragment of Indian pottery.

Rigterink, J. W.—Two specimens of fossiliferous limestone and Indian relic.

Schneider, C. F.—Rock specimen, supposed to be fossil wood.

Selous, Percy.—Fourteen mounted specimens—Mammals, birds, fish and tortoise—from the collection of the late Percy Selous, purchased from the administrator, Dr. I. M. Fisher; 22 mammal skulls. (Purchased.)

Shank, Mrs. R. B.—Lamprey, *Petromyzon sp.,* from Pine Lake.

Shaw, W. T.—Crayfish and fresh-water sponge; 14 mounted birds. (Purchased.)

Snell, Wm. M.—Canada lynx from Rudyard, Chippewa county.

Stark, Robert P.—Mounted marsh hawk and two mounted gophers, *Spermophilus tridecemlineatus.*

Stevens, R. T.—Fossil shark's tooth from Santa Barbara, Cal.

Strayer, Chas.—Lamprey, *Petromyzon sp.,* Red Cedar River.

Strayer, Floyd.—Two minks, *Lutreolo vison,* one a partial albino, from Okemos, Mich.

Students.—Lamprey from Red Cedar River; brown bat, *Vespertilio gryphus,* M. A. C.

Unknown.—Two small shrews, *Sorex sp.,* received through the mail without name or address of sender.

Voiselle, Wm.—Mineral concretions from shore of Anticosti Island, Gulf of St. Lawrence.

Ward's Nat. Science Establishment.—Large crinoid, *Metacrinus rotundus*, from Japan sea. (Purchased.)

Waterman, Dr. Geo. A.—Thread-worms and tape-worms from sheep.

Watkins, Hon. L. Whitney.—Nest of Baltimore oriole built entirely of mule's hair; hickory branch cut off by "pruner"; living opossum from Washtenaw county, Mich.

Weatherwax, Harry.—Piece of whale jaw, with whalebone in place, from Gray's Harbor, Wash.

Weil, Prof. Chas. L.—Red-tailed hawk, *Buteo borealis*, Lansing.

Wheeler, C. F.—Brook trout from Chatham, Mich.

Wilcox, Eber.—Four fossil fish from Wyoming. (Purchased.)

Young, H. C.—Red bat, *Atalapha noveboracensis*, from Grand Rapids, Mich.

Zimmerman, Van.—Feldspar crystals ("Carlsbad twins") from Breckenridge, Col.

Respectfully submitted,
WALTER B. BARROWS,
Curator of the General Museum.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF WOMEN'S DEPARTMENT.

To the President:

Sir—Permit me to submit the following report of the work of the Women's Department for the year 1901-02:

The increased number of women in attendance fully justifies the hopes of the friends of this comparatively new department. The Women's Building has been fairly tested as to its capacity and convenience, and the work done has been very satisfactory both in spirit and in results.

Owing to the large class enrollment it was found necessary at various times during the year to secure additional instructors. In the fall term the class in senior cookery under Miss Crowe proved too large for one instructor. The department was fortunate in securing Mrs. Elizabeth M. Torrance whose efficiency in the department of Domestic Science and helpful spirit in house affairs made her brief stay most pleasantly remembered.

In the winter the work in "Home Nursing" was most satisfactorily given by Mrs. C. L. Barber. Mrs. Barber's long experience and thorough training and her enthusiasm for the work made this course one of great value. The course in "Household Decoration" was conducted during the spring term by Miss Lyford in addition to her regular work in Freshman Cookery.

In the department of Domestic Art the numbers were such as to necessitate the use of the two sewing rooms during the same hour. Valuable assistance in this dilemma was rendered by Mrs. Mae M. Gingles, whose services have been worthily recognized in her appointment as assistant in Domestic Art for the coming year. The wood work room was thoroughly fitted up ready for use in January and is now one of the most attractive features of the Women's Building. Mrs. Haner reports considerable aptitude and skill on the part of the young women for this work.

The work in music, also, was more than one instructor could carry. Mrs. Marshall reports very satisfactory assistance by Miss Hannah Bach, who pursued at the same time most of the studies of the sophomore year.

The department of Physical Training, under the care of Miss Avery, shows good results, and with the gymnasium fully equipped for next year, still greater results may be hoped for. Three hours a week, however, is a small amount of required time. Miss Avery has rendered valuable aid as Health Officer in looking after the sick and in dispensing remedies to those needing attention. The epidemics of mumps and measles were passed through with no serious complications, due largely to her wise precautions and efficient care.

The laundry, fitted up with drying room at a cost of a hundred and fifty dollars, a hand mangle, new electric irons and tables, provides a place for class work for the laundering of the house linen, as well as for the use of individual students.

The house has been open for various social affairs from time to time throughout the year. While these functions involve much labor and time, they are of such importance in women's education as to make them absolutely essential.

The department regrets sincerely the resignation of Miss Belle C. Crowe, whose efficient services as Instructor in Domestic Science in charge of the dining room and kitchen, have been apparent to the most casual observer. Her application of the principles of domestic science to practical affairs has not only served to dignify the drudgery of housework and to make economy attractive but has also promoted greatly the comfort and well-being of the house. Inasmuch as she goes to a field of wider opportunities and with greater remuneration, we can but wish her much success while regretting our own loss.

The dean of the department wishes here to express her appreciation and thanks for the hearty cooperation and support of the teachers of the department and of the president of the College.

Very respectfully yours,
MAUDE GILCHRIST.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF DEPARTMENT OF HISTORY AND ECONOMICS.

To the President:

I take pleasure in reporting the work of the past year in this department.

The curriculum of the autumn term required my teaching two classes in history. The first—course two in European history—was attended by a class of fifty-three young women meeting five hours per week throughout the term, similarly each day per week, another class—one in United States constitutional history elected by twenty-one seniors—met. An essential part of the work for both these classes was reference work in the library, the facilities for which had been much improved by the purchasing with department funds of from four to six copies of some standard history of each period of European history throughout the modern era and throughout the constitutional period of history in our own country. The nucleus—some fifty volumes—thus made of a departmental library will grow, it is hoped, until complete means for research work will be available to members of these classes. The series of Spruner and Bretschneider maps have also proven a useful adjunct to the teaching of European history.

During the winter term classes in Early European history, Political Science and Economics came to me for direction. Students to the number of twenty came in the first mentioned class, fifty-six in the second and twenty-five in the third. Near the end of this term an unfortunate sickness prevented my meeting these classes for a period of two weeks.

The English history of the spring term was taught to a large class of one hundred and eight students divided into three sections. The methods employed in the class room were similar to those of previous years. Topical note books and map drawing exercises form an essential part of the work in this study and each year prove more valuable. By a vote of the faculty Advanced Economics was substituted for the Psychology which should have been taught by me this term. An almost equal division of the time thus allotted was made between industrial history and taxation. The suitability and need to our College curriculum of such study as is given by these two subjects was impressed upon me by the experiences of this term and I earnestly urge that a place be made in the spring term of the senior year for the election of this work regularly.

Respectfully submitted,

WILBUR O. HEDRICK.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING.

To the President:

Sir—It gives me pleasure to hand you herewith my report for the year ending June 30, 1902.

Instruction was given during the year in conformity for the most part, to the program of last year, and along the lines there indicated: The only new course added was one in Practical Optics, given in the spring term at the request of twenty-three seniors in the Agricultural and Women's courses. For the most part this course was completed in a very creditable manner, and with results which must prove of great value to the students in their chosen callings.

Enrollment for the several terms was as follows:

Fall term—			
Ag. soph	44		
Mech. soph	38		
Total	——	82	
Winter term—			
Agrl. fr	56		
Mech. sen	10		
Mech. fr	73		
Women soph	14		
Women fr	54		
Total	——	207	
Spring term—			
Agrl. sen	20		
Women sen	3		
Agrl. fr	47		
Mech. fr	62		
Mech. sub. fr	46		
Women fr	52		
Total	——	230	
Grand total		——	519

The Teaching Force was increased by the addition, in the spring term, of a temporary assistant; for which position Mr. L. G. Holbrook was engaged. I am glad to report his work very satisfactory. This position has since been made permanent, an action which will add much to the strength of the department work.

The Apportionment for current expenses has for several years been unchanged; and has required the most economical administration to avoid a deficit, often times at the expense of the best results. The rapid increase in the number of students for whom the department must provide material and equipment calls for as large an increase in this fund as can be made.

The recent provision, for increased facilities for the work of the department in the near future, will make possible its much needed development along electrical lines, while adding also to the work as a whole.

In closing it gives me great pleasure to say that there has been a very marked improvement in the character of the work done in our courses for the current year.

Very respectfully submitted,
MARTIN D. ATKINS.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF DEPARTMENT OF BACTERIOLOGY AND HYGIENE.

President J. L. Snyder:

DEAR SIR—The college work has been conducted in much the same manner as last year, but with an increased number of students. The growing demand for bacteriology comes through its intimate relation with agriculture and domestic science and each year demonstrates more forcibly its need to a successful performance of duty in these fields.

A working knowledge of bacteriology is indispensable in certain practical lines of agricultural and domestic operations and we shall aim to emphasize such work as will be of the greatest utility to the student when he leaves school. We do not strive to make bacteriologists but rather to make bacteriology subservient to agriculture and domestic science. In a technical institution, it is a means to an end, one weapon to be used in the fight for success.

Owing to the crowded condition of the laboratory we have been unable to carry on the work as has been desired, but the students deserve much credit for their patience in struggling against inconvenience and limited facilities. They have always understood the situation at the beginning of the year. However through the generosity and kindness of the Board, this fall we enter a new laboratory which will doubtless give many advantages and increase our working capacity. This enlarged scope we trust will pave the way to the understanding of certain agricultural and domestic science problems which the students could not study at all in the past.

It is desired also that provision may be made whereby it will be possible for special students to obtain what they seek in connection with their professions as in creamery work and cheese making and other vocations in which bacteriology is fundamental.

The new course adopted during the last year will also place the work of this department on a better basis, and will make it possible to undertake systematic work from the time the student enters school till he finishes.

Mr. S. F. Edwards deserves much praise in the management of laboratory classes.

Most respectfully submitted,
CHARLES E. MARSHALL.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF DEPARTMENT OF DRAWING.

To the President:

Dear Sir—I have the honor to present herewith the report for the Department of Drawing for the year ending June 30, 1902.

At the beginning of the fall term as it became necessary to have more room for the accommodation of students in draughting the department secured the use of a room in the dairy building and had it fitted with drawing tables, and lockers for material. This increase in facilities has been of material assistance to the department, but of course is only a temporary relief.

The department has taken upon itself the teaching of two of the studies in the new elective course in Civil Engineering, i. e., "Shades and Shadows and Perspective," and "Topographical Drawing and Sketching," the former of which was given to a class of eighteen junior engineers in the winter term. These electives add materially to the work of the department.

A very trying feature of the conditions under which our work is conducted is the scattering of class rooms, appliances, etc., in three somewhat widely separated buildings. There is in this a manifest loss in several ways.

The distribution of classes and hours among the members of the instructing force is clearly shown in the reports made to you at the opening of each term.

In addition to carrying a due proportion of instructing I have been acting as class officer of the Mechanical Sub-Freshman class, a work that requires no little time and attention, especially at the opening of the term when an instructor's best efforts are demanded by his class work.

The work of the department, while it has been materially increased, has moved along smoothly, and we trust with an increased benefit to the student.

Faithfully,
W. S. HOLDSWORTH.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF THE DEPARTMENT OF PHYSICAL CULTURE.

President J. L. Snyder:

The facilities for athletic work at the beginning of the collegiate year were inadequate both in respect to time and place. The use of the parade ground as an athletic field allowed but three afternoons a week and the continuation of recitations for some classes until five o'clock left but little time for actual practice. Especially was this true as the season advanced and the days became so much shorter. Considering these two great disadvantages and the fact that the last two years little had been done in football and baseball, the results attained by the football team were most encouraging and brought the College from the last place in the M. I. A. A. to that of second.

There was a dearth of base ball material, particularly pitchers. An entire new team had to be developed and was almost entirely composed of freshmen and sophomores. While the season was not so successful as had been expected, many of the games were well played, and give promise of a very good team the coming year.

The track team won the inter-collegiate meet held at Albion in June by a score of 80 points, the next nearest being Albion with 72 points. At this meet the relay team won the relay banner, which has not occurred in many years. Two dual meets were held earlier in the spring, one with Alma and the other with Albion, both of which M. A. C. won by a large majority of points. The basket ball team did not lose a game and was the fastest team in the State. In wrestling the team in three different meets never lost a bout in any weight except the heavy.

The gymnasium in the women's department has been well patronized, and the classes given three times a week under the instructor, Miss Avery, have been most successful. The young women had basket ball teams which were most excellent and showed faithful training.

The State Board kindly appropriated money to fix the new athletic field across the river so that now the college has a separate field for athletic work, which, when completed, will be as fine a field as any in the country. During the fall term in order to give more time electric lights should be placed on the field. Arrangement should also be made in some way so that during the winter term the use of the armory might be allowed the department more than once a week as during the year just ended.

The department would advise the payment of a dollar a term by every student to the support of athletics and physical culture. This small fee would run the department and association easily and would be a strain upon nobody.

Respectfully submitted,
GEORGE E. DENMAN.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF THE VETERINARY DEPARTMENT.

To the President:

SIR—I have the honor of reporting for the Veterinary Department that the work in the department for the past year has been very similar to that given in my last report. About the same number of students elected the work, those electing it manifesting a good degree of interest. The young men who anticipate returning to the farm, and the raising of stock, appreciate the work of the department, and it is to these especially that we devote our attention.

Respectfully submitted,
GEO. A. WATERMAN,
Professor of Veterinary Science.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF THE DEPARTMENT OF ENGLISH AND MODERN LANGUAGES FOR THE YEAR 1901-02.

To the President:

SIR—The personnel of the English Department during the year 1901-02 consisted of Miss Georgiana Blunt, Mr. E. S. King, Miss Bertha Wellman and myself. In accordance with the arrangement entered into the previous year, I undertook the editing of the RECORD, the daily programs, the advertising, etc.; in return for which Mr. P. H. Stevens of your office, was put under my direction for the teaching of certain English classes and for such other work as I might assign. This arrangement was continued for two terms. In the third term I found that the exigencies of the work in higher English, French and German were such that satisfactory assignments could not be made without my taking a full quota of class work. I therefore requested to be relieved of all editorial work at the same time returning Mr. Stevens to your office. This was done. Miss Lucy Davis, who had been teaching two classes in French during the first two terms of the year, resigned her work during the early part of the third term; and, with your consent, I engaged Miss Zoe Benton of Washington, D. C., to take the beginning class, while I conducted the other class during the remainder of the term. During this term I also taught a small voluntary class in Latin.

Miss Blunt, having determined to go to Europe for further study, placed her resignation in your hands to take effect September 1, 1902. Miss Blunt has been for some four years an able, efficient and zealous officer in this department, and I take pleasure in recording my sincere and hearty appreciation of her exceptionally brilliant work. To fill the vacancy thus created, and to cover the work done by Miss Davis and Miss Benton, I recommend that Mr. King be advanced to the position of assistant professor of English, that Mr. L. W. Sawtelle, B. S., of Chicago University, be elected instructor in English, German and French, and that $500 be set aside for the payment of essay readers as necessity should arise. These arrangements were sanctioned by yourself and adopted by the Board of Agriculture. They do not increase the aggregate outlay of money for the department, and by thus shifting to the essay work the contingent employment of subsidiary help, I am sure that the efficiency of the work of the department will be increased.

The only change made during the year in the character of the work was in English 1. Instead of devoting the five hours of the first term of our work to the study of elementary English grammar, as heretofore, I required the entrance examination to cover that work fully, and used the time of this term in studying the powers and values of the various forms of the English sentence, its clauses and phrases, for the expression of thought. The work has been heartily entered into by the members of the department.

The addition of a year to the agricultural and women's courses has made it necessary to rearrange the order of English work, and accordingly, for the coming year, I have placed in the sub-freshman year of all the courses (except for the fact that in the mechanical course the total time allotted to English in the sub-freshman year is less by two hours than in the other two courses) English 1a (three hours), English 1b (three hours), English 2a (two hours), English 2b (two hours), English 2c (two hours), and English 2d (three hours). This will enable students to begin their English work in all the four-year courses at the point where the better class of high schools will leave them.

Respectfully submitted,
HOWARD EDWARDS,
Professor.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF THE DEAN OF SPECIAL COURSES.

President J. L. Snyder:

The attendance at the special courses during the winter of 1901-1902 was as follows:

Sugar beet course	25
Live stock	24
Creamery	24
Cheese	16
Fruit	5
Total	94

The course in beet sugar production was much amplified this season. In the first place the chemical side of the instruction was unified and enlarged. Next, the Lansing sugar factory was completed and the owners were kind enough to allow our students the use of their most excellent plant as a laboratory for teaching the arrangement of the machinery and the function of each piece of the costly apparatus. The thanks of the College are due the management of the factory for their generosity in the matter. This practical work in the factory, the opportunity to study pipes, tanks, batteries, multiple effects, strike pan and all other parts of a working sugar factory has been a great help to our students. They leave us ready to take up practical every day work in a factory without the danger incident to going into an immense establishment totally ignorant of the working parts.

A change will be made next year in the matter of the teaching of the agricultural work of the course. When young men come to this course from the farm it is quite possible to give them intelligent training in matters connected with the raising of beets, but when they come here from the city, without training in the fundamental operations of farming, any attempt to give them intelligent methods of beet growing can but be farcical. Hereafter therefore the course should provide for a division of the class as to this work.

I am glad to report that the call for our graduates keeps acute and every man will be satisfactorily placed before the beginning of the next campaign.

The live stock and creamery courses were fairly well attended. The cost of the creamery course was much reduced because the farm department had in operation a regular factory and the students were allowed to manage the creamery during the continuance of the course, thus dispensing with the necessity of buying the milk for this especial purpose.

No radical changes in management were introduced this year. The cheese men were trained by Mr. Michels and were well pleased with the work. We have secured a satisfactory place for each of the members of the class.

The work in the fruit course was entirely satisfactory and all in attendance were well satisfied.

For next year I suggest a change in one very important respect. I propose a lengthening of the courses to twelve weeks with an opportunity to choose between certain lines as the one factor upon which the student shall lay the emphasis.

Respectfully submitted,
CLINTON DEWITT SMITH,
Dean.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF THE DEPARTMENT OF BOTANY AND FORESTRY.

To the President:

The following in brief is my report for the year ending June 30, 1902:

During the past year students have received instruction in this department as shown in the table below:

Class.	Subject.	Term.	Hours per wk.	No. of students enrolled.
Resident graduates	Structure of wood	One, each term counting.	10	3
Senior	Plant physiology	Fall	5	14
Junior	Parasitic fungi	Fall	9	34
"	Grasses	Winter, four weeks	5	28
"	Weeds	" " "	5	28
"	Forestry	Winter, three times per wk	3	31
"	Plant ecology	Spring	3	32
"	Trees and shrubs	Sring, half term	2½	39
Sophomore (men)	Plant histology	Winter	9	47
" (women)	Plant histology	Spring	7	19
" (women)	Trees and shrubs	Spring	2½	12
Freshmen	Begin botany	Fall	7½	139
"	Systematic botany	Winter	2	118
Special course	Begin botany	Winter, six weeks	7½	6
Special course	Botany of sugar beets	Spring	2	21
Total				571

The teaching force of this department has remained unchanged, excepting that Mr. Brown taught one section of the freshman class of 25 students for the fall term.

Last year the class roll numbered	493
This year now closing	571

An increase of 78.

THE HERBARIUM.

The additions have been as follows:

Seed plants, ferns and their allies.

C. O. Rosendahl & C. J. Brand, plants of Vancouver Island	97
H. P. Baker, plants of Nebraska	148
S. M. Tracy, plants from Florida and vicinity	400
W. W. Eggleston, plants of New England	92
W. C. Cusick, plants from Oregon (1901)	262
W. C. Cusick, plants from Oregon (1902)	137
Mrs. A Chase, plants from Chicago	26
A. Phelps Wyman, collected in Arnold Arboretum	212
C. D. McLouth, plants from Muskegon Co.	36
W. J. Beal, Coniferae from Colorado	10
W. J. Beal, plants from Greenville, Mich	9
Home collections	150
	1,579

FUNGI.

W. A. Kellerman, Ohio fungi	42
U. S. Dept. Agriculture desiderata	85
Arthur and Holway, Uredineae	28
S. M. Tracy, from Florida	17
A. D. Selby, Ohio	4
Home collections	60
	236

ALGAE.

Collins, Holden, and Setchel, Fascicle 17	50
Collins, Holden, and Setchel, Fascicle 18	50
J. E. Tilden, American Algae, Century V	100
J. E. Tilden, American Algae, Century VI	100
	300
Total additions for the year	2,115

GENERAL SUMMARY OF PLANTS IN THE HERBARIUM.

Seed plants (Spermatophyta)	62,206
Ferns and their allies (Pteridophyta)	1,142
Mosses and Liverworts	1,887
Lichens	1,135
Fungi	13,189
Algae	1,695
Total number in the herbarium	81.254

THE BOTANIC GARDEN.

The area of two acres has been slightly increased by grading and filling on the bank below where plants have been grown. This new area will be devoted to samples of grasses which were given up in the area near the boiler house. Any new area broken up and planted to a miscellaneous variety can be cheapest and most satisfactorily cultivated for the first five or six years, but after that the plants here and there begin to fail or dwindle in size. Some of them will become troubled with fungi or insects or both. The plants should then be shifted to other places, the soil much enriched, or the old soil removed and other soil put in its place. With a very small area devoted to each species, it seems in most cases of little use to attempt spraying. Gooseberries and currants and roses and a few others may be sprayed to advantage.

THE ARBORETUM AND THE COLLEGE FOREST.

Last winter labor was high and very scarce. Two men worked most of the winter cutting stove wood and three-foot wood in the woods north of the Pere Marquette; stove wood at 50 cents, and three-foot wood at 60 cents per cord. The College teams charged 30 cents per hour for hauling. There were cut 485 cords of stove wood and 85 cords of three-foot wood.

A few loads of logs of sled length were drawn and sold to neighbors. Two quarts of sprouting chestnuts were planted in open places this spring in the lot between the railroads. One Sunday in May when the leaves were very dry some one set them on fire in the lot south of the river—the west half south side. This killed considerable of the small growth, the size of one's thumb and smaller. On pleasant Sundays there are a good many strolling through the woods, some of whom are sure to be smokers. Foreman Blair, aided by several others, stopped the fire after some damage was done.

The pines in the extreme east wood lot up the river have done well where the soil was good, some of them last summer and the year before shooting up a leader two-feet nine inches each year. Some of the trees are now over twelve feet high. This spring a single row of year-old box elders was planted east and west between each two rows of white pine. These will spread and keep down the grass and crowd the pines to keep off the lower limbs and induce the trees to grow tall.

North of these pines a piece of river bottom one hundred and twenty square rods in extent was plowed last fall. This spring it was planted to a mixture of trees about four feet each way, mostly silver maples, box elders, basswoods, with a smaller number of arbor-vitae, balsam fir, hemlock, Norway spruce, white spruce, red cedar, larch, white pine. They have been cultivated one way like rows of corn. The small arboretum remains as it was last year, excepting the growth of trees.

DONATIONS.

From A. G. Green, Walled Lake, Mich., specimens of fruits of Thuya orientalis.

From D. S. Bullock, Hadley, Mich., galls on oak from Texas, also pods of coffee bean tree.

From Pearley Burcham, Lansing, Mich., a block of black oak split to show the process of healing where the trimming was well done.

From Hugh P. Baker, Washington, D. C., 150 herbarium specimens from Nebraska.

Thanks are again tendered Professor C. F. Wheeler and Instructor B. O. Longyear for faithful services during the year now closing.

W. J. BEAL.
Professor of Botany and Forestry.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF THE LIBRARIAN.

To the President:

Sir—I have the honor to present the following report on the library for the year ending June 30, 1902:

Seven hundred ten bound volumes have been added to the library during the year, 435 of which were purchased, 124 were donated, and 151 came by binding. Pamphlets and unbound volumes to the number of 347 have been received, 13 of which were purchased; the remainder, 334, were presented to the library, and acknowledgment made whenever the donor was known. We therefore omit individual mention. For bound volumes we are indebted as follows:

American Shorthorn Association, 2 vols.
Australia, Bureau of Agriculture, 2 vols.
Burrows, Hon. J. C., 13 vols.
Brown Hoisting Machinery Co., 1 vol.
Canada Geological Survey, 4 vols.
College Y. M. C. A. Organization, 1 vol.
Connecticut Board of Agriculture, 1 vol.
Deering Harvester Co., 1 vol.
Edwards, Dr. H., 1 vol.
Hampshire Down Breeders' Ass'n, 1 vol.
Holstein Friesian Association, 1 vol.
Massachusetts Board of Agriculture, 1 vol.
Michigan Board of Health, 1 vol.
Michigan Board of Agriculture, 1 vol.
Michigan Board of Commissioners, Buffalo Exposition, 1 vol.
Michigan Legislative documents, 15 vols.
Michigan Pioneer Association, 1 vol.
Michigan Secretary of State, 11 vols.
Michigan Superintendent of Public Instruction, 1 vol.
Michigan Horticultural Society, 1 vol.
Missouri Botanical Gardens, 1 vol.
National Conference Charities and Corrections, 1 vol.
New South Wales, Secretary of Agriculture, 1 vol.
Shropshire Breeders' Association, 1 vol.
Smith, Hon. S. W., 11 vols.
Smithsonian Institution, 3 vols.
United States Reports as follows:
    Department of Agriculture, 8 vols.
    Labor Bureau, 2 vols.
    Bureau American Republics, 11 vols.
War Department, 1 vol.

One hundred fifty publications, foreign and American, are purchased by the library and placed in the reading room for the use of faculty and students. In addition to these are the following publications which are regularly received as donations or in exchange for our own publications:

Adrian Times.
Allegan Gazette.
American Beekeeper.
American Blacksmith.
American Creamery.
American Horsebreeder.
American Horticulturist.
American Phil. Society Proc.
American Swineherd.
Baltimore Sun.
Battle Creek Journal.
Beet Sugar Gazette.
Belding Banner.
Capital City Democrat.
Chicago Drovers' Journal (daily).
Chicago Record Herald (daily).
Christian Science Herald.
Christian Science Journal.
Christian Science Sentinel.
Clinton Independent.
Detroit Free Press (twice-a-week).
Dairy and Produce Review.
Evening News (Saginaw).
Everybody's Magazine.
Farm and Fireside.
Farmer's Voice.
Farming World.
Farm; Field and Fireside.
Farmers' Advocate.
Farmers' Home.
Farmers' Guide.
Farmers' Journal.
Farm and Home.
Farm Journal.
Fruit Growers' Journal.
Good Health.
Gleanings in Bee Culture.
Grand Ledge Independent.
Grand Rapids Evening Post.
Grange Bulletin.
Homestead.
Hillsdale Leader.
Hillsdale Standard.
Horse World.
Horticultural Visitor.
Improvement Era.
Indiana Farmer.
Ionia Sentinel.
Lansing Journal (daily).
Lapeer County Press.
Lewiston Journal.
Literary News.
Live Stock Journal.
Locomotive.
Midland Republican.
Michigan Mirror.
Michigan Sugarbeet.
Michigan Bulletin Vital Statistics.
Moderator.
National Stockman and Farmer.
New York Produce Review.
New York Weekly Witness.
Otsego County News.
Onekama Lake Breeze.
Oregon Agriculturist.
Orange Judd Farmer.
Official Gazette.
Pinckney Dispatch.
Petoskey Independent Democrat.
Public Ledger (Phila.) daily.
Pratt Institute Monthly.
Park's Floral Magazine.
Practical Farmer.
Proc. Amer. Soc. Civil Engineers.
Science and Industry.
South Haven Messenger.
Sugar Beet.
Sunfield Sentinel.
Travelers' Record.
Traverse Bay Eagle.
Voice.
World's Fair Bulletin.
Western Fruitgrower.
Wolverine Citizen.
Women's Home Companion.
Wallace Farmer.
West. Soc. of Engineers.
Williamston Enterprise.
Yale Expositor.
Ypsilantian.

The M. A. C. Record exchanges are also placed in the reading room, and in exchange for our catalogue, the library receives the year books, catalogues or registers from all the leading educational institutions of the country. We also receive the bulletins of the various State experiment stations, and of the U. S. Department of Agriculture.

During the year fines to the amount of $21.36 have been collected, and 4,500 books have been loaned. (No record is kept of books used in the library.) Ninety-five books have been repaired or rebound.

The library is open to students eleven hours daily, except Sunday, when the library hours are from 9 to 12 a. m.

In September the State Board of Agriculture appointed Mr. H. M. Goss to the position of assistant librarian. Mr. Goss remained with the library until April 15, when he resigned to accept a position in the College post-office. Mr. Herbert Patriarche, a member of the class of '02, was appointed to fill out the unexpired term, and has been retained for next year. While we regretted losing Mr. Goss, whose work in the library was always satisfactory, we congratulate ourselves on securing as his successor one who manifests a decided interest in library work, and whose appointment is so generally approved.

To the library of the Experiment Station have been added 43 volumes; 8 by purchase, 10 by gift, 25 by binding. This library now numbers 1,987 volumes. The College library contains 21,089 volumes. Total in both libraries, 23,076.

Respectfully submitted,
LINDA E. LANDON,
Librarian.

Agricultural College, Mich.,
June 30, 1902.

ANNUAL REPORT OF THE MICHIGAN WEATHER SERVICE FOR THE YEAR ENDED JUNE 30, 1902.

The Michigan Weather Service has continued under the immediate charge of C. F. Schneider as Director, who is detailed by the Chief of the U. S. Weather Bureau.

The headquarters of the office continue in the Federal Building at Lansing, rooms 9 and 10.

The entire energy of the office force has been along lines followed during the preceding years and much progress has been made in strengthening the voluntary observation work and getting the forecasts and coldwave warnings before the rural communities. The total number of voluntary observation stations at the close of the year was 120; at least one station is located in every county in the State with the exception of Montmorency, where we have been unable to make any practicable arrangement for observation work, but it is hoped that another year will see that this exception is supplied. As a whole, the work of the voluntary observers has greatly improved; a number of changes have been made in the personnel with a view of getting more accurate and regular reports, while a majority of the old voluntary observers have been better trained so that it can safely be said that the meteorological records of Michigan are not excelled by any other State in the Union.

The administrative problem of securing and keeping voluntary meteorological observers is, and must always be, one of the great items of work connected with my office. When it is remembered that there is absolutely no remuneration for this work, which requires daily attendance throughout the year, the difficulty can be appreciated. The meteorological record to be of value must not only be taken with standard instruments, but should be regularly taken at a stated time every day which does not exclude Sundays and legal holidays. The only way that the service can show its appreciation of this constant, daily labor is by furnishing the observers with all of our publications and by cordial relations with them. We have been quite fortunate in securing some valuable publications and also a considerable allotment of seeds and by visiting them occasionally and inspecting their instruments, splendid results have been attained. The data which is collected by the voluntary observers is daily becoming of more value to the citizens of the State and what is more to the point, the State at large is coming to appreciate them by using the reports more and more. At present with our 120 stations and 9 regular weather bureau stations the State is well covered with a network of carefully obtained data and too much credit cannot be given to the voluntary observers, both individually and collectively, for their splendid work.

The forecast distribution continues very large and through the medium of the rural mail route is reaching out in the agricultural communities, where it is of great value, and as the farmer learns to use and appreciate the forecast he will soon be able to get as much benefit therefrom as his commercial brothers of the larger cities. It is hoped that in another year, when improved facilities for distributing forecasts will probably be available, that we will be able to reach thousands of farmers promptly every day, who have never before been in receipt of the forecasts.

The Weekly Climate and Crop Bulletin continues holding a high place in the estimation of the public. It has been published during the past year during the planting, growing and harvesting seasons and is widely published both in the newspapers of the large cities and also in the smaller country newspapers. The great demand for the bulletin and the information it contains is the best criterion of its value to the people at large. It is furnished free on application to the Lansing office.

A monthly and annual summary have been published as in previous years without any particular change. They are homogeneous in data and style to the bulletins published in other states so that they are more readily appreciated by all readers and make our work comparable with all other state weather services. This is a very important desideratum. As a matter of record these bulletins are widely sought for and much used.

No particularly new work has been taken up by the service, but the work which has been in hand for some years back has been vigorously prosecuted and much office work done in the way of compiling back records and putting them in handy shape for ready reference so that the files at Lansing are easily referred to and very handy to get at.

C. F. SCHNEIDER,
Director.

LANSING, MICHIGAN,
June 30, 1902.

MILITARY DEPARTMENT.

Hon. J. L. Snyder, President:

SIR—I have the honor to submit my report of the Military Department for the year ending June 30, 1902.

The work has been carried on on the same lines as that of the previous year, the model being the system pursued in the regular service. A marked improvement has been shown in the discipline and deportment as well as in the dress of the cadets; there is also a great desire among them to obtain the positions of officers and non-commissioned officers, showing that the work of the department is becoming more popular. Four additional second lieutenants were appointed this year from the senior class with a view to their being made captains in their senior year. It is believed this will greatly help the work, as heretofore new officers have been made each year, who have not had the necessary experience to enable them to fully do their work.

I again request that the faculty allow more time for the course—three hours a week being entirely insufficient—also that the hour for class work with the sophomores does not conflict with the drill hour during the winter term.

It gives me pleasure to report the good conduct of the freshmen class, whose gentlemanly behavior has been all that I could desire; I can also say this of the great majority of the corps.

The officers who graduate this year are a fine manly lot of young men who are fully competent to fill the position of second lieutenant of volunteers, if the country should ever need their services. The attention of the Board is again invited to the necessity of a complete separation of the Athletic from the Military Department. The new ground has greatly aided me in my work, and a proper drill shed, in which the whole battalion could be handled, would do more for my department and the College than anything I can suggest.

Very respectfully,

C. A. VERNOU,
Major U. S. Army.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

President J. L. Snyder:

The work of instruction in the Chemical Department has been divided among the following classes:

General chemistry	175 students
Analytical chemistry	72 students
Minerology	68 students
Organic chemistry	43 students
Quantitative (metals)	50 students
Agricultural chemistry	40 students
Meteorology (elective)	35 students
Beet sugar production (special)	25 students

The work of our students still shows the old-time zeal and interest. Original investigation by each student into the facts and laws of chemistry is still as popular as ever. I believe that there is a large field for the study of chemistry as applied to the problems of domestic economy, and therefore I would recommend that in the senior year of the course for women ten hours per week be devoted to this subject.

The class in general elementary chemistry being the largest so far in the history of our College leads me to urge the necessity of providing space for the Department of Physics outside of the chemical laboratory in order that not only we may better accommodate our students in their laboratory work but also provide more room for the chemical work of the Experiment Station.

The special course in beet sugar production, the fourth session of which has just closed, affords an opportunity for our young men to become acquainted with the details of the manufacturing process and has succeeded in supplying the factory managers with useful assistants. Through the kindness of Mr. Boutell, our present year's class spent two weeks studying in detail the construction of the machinery in the factory of the Lansing Sugar Company under the guidance of Mr. A. N. Clark, assistant superintendent of the Alma factory, who gives the technical instruction in our special course.

In addition to the class work there has been the usual amount of analytical work undertaken, including fertilizing materials, soil and water analyses, minerals, feeding stuffs, etc.

I wish to acknowledge the hearty cooperation of all the laboratory force helping to bring to a successful close the 39th year of my professorship.

Respectfully submitted,

R. C. KEDZIE,
Professor of Chemistry.

AGRICULTURAL COLLEGE, MICH.,
July 1, 1902.

FIFTEENTH ANNUAL REPORT

OF THE

EXPERIMENT STATION

OF THE

STATE AGRICULTURAL COLLEGE OF MICHIGAN

UNDER THE HATCH ACT

FOR THE

YEAR ENDING JUNE 30, 1902

For members and organization of the State Board of Agriculture in charge of the Station, and list of officers, see page eight of this volume.

EXPERIMENT STATION.

REPORT OF SECRETARY AND TREASURER.

The following account shows the receipts and expenditures of the Experiment Station for the year ending June 30, 1902:

		Dr.	Cr.
July 1, 1901—To	balance on hand	$616 15	
July 5, 1901	received from U. S. Treasury	3,750 00	
Oct. 5, 1901	received from U. S. Treasury	3,750 00	
Jan. 8, 1902	received from U. S. Treasury	3,750 00	
April 7, 1902	received from U. S. Treasury	3,750 00	
June 30, 1902	license fees on 93 brands commercial fertilizers	1,860 00	
	miscellaneous receipts	1,359 99	
	farm receipts	2,736 08	
	from State appropriation, South Haven	2,000 00	
	from State appropriation for U. P. Experiment Station	3,000 00	
June 30, 1902—By	disbursements as per vouchers filed in the office of the State Auditor General		$24,346 75
July 1, 1902	balance on hand		2,225 47
		$26,572 22	$26,572 22

From thirty-five to forty thousand copies of station bulletins are now issued, and the demand is increasing as farmers learn of their value. Several press bulletins have been issued and special information in bulletin form has been sent out by the station.

DISBURSEMENTS ON ACCOUNT OF U. S. APPROPRIATION.

Salaries:		
Assistants to scientific staff, No. employed 4	$1,290 00	
Director and administrative officers, No. employed 6	1,374 12	
Scientific staff, No. employed 7	4,600 00	
		$7,264 12
Labor:		
Monthly employees, 2; average rate, $32.75	$786 00	
Daily and hourly employes	1,685 05	
		2,471 05
Publications:		
For printing annual report, 29 pages (edition 8,000)	$75 27	
Half tones, mailing list, etc	32 20	
Bulletin envelopes and reports	190 00	
		297 47
Carried forward		$10,032 64

Brought forward		$10,032 64
Chemicals:		
Chemical supplies		206 67
Seeds, plants and sundry supplies:		
Agricultural	$222 62	
Horticultural	163 57	
Miscellaneous	631 05	
		1,017 24
Tools, implements and machinery:		
Repairs	$24 85	
New purchases	173 94	
		198 79
Furniture and fixtures:		
One desk	$22 50	
One chair	5 00	
		27 50
Scientific apparatus:		
One microscope	$75 00	
One balance	183 00	
One Geissler pump	40 00	
Sundry items	472 63	
		770 63
Live stock:		
Cattle	$1,004 00	
Sheep	74 52	
Swine	25 50	
Sundries	16 30	
		1,120 32
Traveling expenses:		
In supervision of station work		125 92
Building and repairs		221 20
Postage and stationery		286 75
Freight and express		198 10
Feeding stuffs		594 68
Library		199 56
Total		$15,000 00

DISBURSEMENTS OF EXPERIMENT STATION—MONEYS OTHER THAN RECEIVED FROM UNITED STATES TREASURER.

Salaries	$2,309 56	
Labor	3,168 45	
Publications	424 09	
Postage and stationery	80 79	
Freight and express	80 03	
Chemical	33 25	
Seeds, plants and sundry supplies	945 63	
Fertilizer	35 05	
Library	2 66	
Tools, implements and machinery	44 51	
Furniture and fixtures	4 20	
Scientific apparatus	52 88	
Building and repairs	1,722 99	
Traveling expenses	296 64	
Live stock	31 50	
Feeding stuffs	114 52	
		$9,346 75
Balance on hand		2,225 47
Total		$11,572 22

REPORT OF THE DIRECTOR.

To the President:

There have been issued in the year ending June 30, 1902, the following bulletins:

No.	Title.	Author.	Department.	Pages.
193	Beet Pulp as a Cattle Food	C. D. Smith	Agricultural	
194	Report of South Haven Sub-Station	S. H. Fulton	Horticultural	
195	Strawberries	L. R. Taft and M. L. Dean	Horticultural	
196	Vegetable Tests	L. R. Taft and M. L. Dean	Horticultural	
197	Sugar Beet Experiments for 1901	J. D. Towar	Agricultural	
198	Sand Lucerne	J. D. Towar	Agricultural	
199	Cow Peas, Soy Beans and Winter Vetch	J. D. Towar	Agricultural	
200	Some Insects of the Year 1901	R. H. Pettit	Entomological	
201	Aeration of Milk	C. E. Marshall	Bacteriological	
202	Fertilizer Analyses	Dr R. C. Kedzie	Chemical	

One special bulletin has been issued in the meantime, making Number 16 in that series. It was entitled Aeration of Milk, and was written by C. E. Marshall, the Bacteriologist of the Station. A brief resume of this bulletin was published as Number 201 of the regular series, while in the special bulletin was given the tables and details of the experiments on which the conclusions set forth in the regular bulletin were based.

I submit, herewith, copies of the bulletins, with the reports of the heads of the various divisions. These reports, as below, give a complete and accurate idea of the work of the Station during the year closing the first of January, 1901.

The time of the Agriculturist was devoted during the summer of 1901 very largely to work on sugar beets. That work was itself confined to tests of different combinations of nitrogen, phosphoric acid and potash, with some work as to the distance apart of rows and other details of growing the crop. The bulletins mentioned above report that work in full, and give evidence of the fact that it is carried as far as needed at the present time. For 1902, therefore, we have planned a different line of work for this new crop, continuing and enlarging the work with the details of sowing and harvesting, as to distance apart of rows and methods of doing the work. We have enlarged the line of investigations as to methods of preventing fungus and insect diseases by spraying and the application of certain kinds of fertilizers, the work being done in co-operation with the Department of Agriculture. A second, and no less important, series of experiments is aimed toward the production of beet seed in this State. For this purpose some land was obtained of Marvin Pickett, three miles east of the College, upon which seed of several varieties furnished by the Department of Agriculture has been sown. The plots are well fertilized, and the soil excellent in quality. The third line of work is the testing of varieties. In this matter the program has been changed. Heretofore, seed has been sent to the Station direct from the growers who have stated that the samples sent fairly represented the seed sold to the factories under the name given. The results of the variety tests have then been published as showing what seed of a given name would do. The seed used in the variety tests this year have been obtained from the factories themselves, each factory sending us ten pounds of each variety of seed used by its patrons. In this way the tests at the Station correspond, as far as the seed used is concerned, exactly with the work of the farmer who gets his beet seed from the nearby factory. Three series of plots are used in the variety tests—one on the College farm, another on the farm of Mr. N. V. Goodnoe, three miles west of Lansing, and a third on the farm of Fred Church, near Alma.

In cooperation with the Department of Agriculture at Washington, the Station is conducting some experiments to test the relative values of clover seed grown in different parts of this country and in various European countries. These experiments have not matured into results as yet which are ready for publication. It should be reported here, however, that the plants grown from different samples of seed are widely different in appearance and value, besides being widely different in their ability to withstand diseases. Results of economic importance are sure to follow. As to dates of sowing, results have accumulated sufficient to warrant the publication of a bulletin as soon as the weighings from the harvest of this season are completed.

The work on the Davenport plots, so called, being the plots laid out twelve years ago or more for work in crop rotation, is approaching the time when results will be ready for publication. The effect of different rotations on the fertility of the soil and the growing crops is becoming more and more apparent and the final influence of successive applications of different fertilizers and different mixtures of fertilizers is also being more apparent. Final results in these series of plots cannot be expected, according to the plan adopted, until 1905, when the work will be available for publication. Other experiments are under way to test the relative influences of various crops on the soil itself and on succeeding crops. prominent among the crops to be tested in this particular comes the sugar beet. It is a matter of prime importance just at this time to know exactly how seriously the growing of a crop of sugar beets on a given area injures succeeding crops.

Cow peas, soy beans and other legumes are growing in popularity among the farmers, and for that reason experiments on a somewhat large scale are undertaken at the College and elsewhere in cooperation with farmers who are feeding a large amount of stock, and can therefore utilize these new crops in feeding. The aim is to test the feeding value separately of the different varieties of cow peas, especially testing, also, the value of corn hill and Southern Prolific beans for planting with corn for silage.

On the sand dunes along the west coast of the State experiments are under way in cooperation with the Department of Agriculture at Washington to find means of preventing the drifting of the sand.

Among the comparatively new lines of work to be begun may be mentioned the analysis of stock foods in the markets of Michigan for the purpose of discovering their condition at the present, and determining the advisability of any legislation in regard to them. At the same time samples of so called breakfast foods and substitutes for coffee and other condiments will be collected for analysis and examination.

The work with wheat will be continued, improving varieties by selection and by cross breeding. The attempt to find varieties which are especially resistant to Hessian fly has not met with success at this Station. It is possible that by the selection of individual plants in varieties which are most promising in this respect that the Stations will be able to develop strains which are resistant alike to Hessian fly, to rust and to smut. At the same time, one of the prime factors to be considered is the milling qualities of the wheat, and in the work of improvement this is the first item regarded.

The time of the Botanist during the last year has been taken up with various lines of work of extreme importance to Michigan, although not recorded in bulletins. In the first place, the number of samples of seeds examined for adulteration and per cent of germination is increasing. The sugar factories have come to rely quite largely on the reports made to them by Professor Wheeler as to the vitality and germination of seeds offered them, and the farmers are sending in more and more samples of clover and grass seeds for examination. Next, the number of fungous diseases naturally increases as the country becomes more thickly settled. The clover is now subject to a disease unknown a few years ago which is assuming serious proportions. Sugar beets offer a new and very active field for investigation. The fruit trees have to be watched continuously for approach of new forms of old diseases, if not for kinds of diseases heretofore absolutely unknown.

The Bacteriologist has devoted his time to the study of questions relating to a pure milk supply in the cities and to the creameries and cheese factories. The bulletin issued does not contain the conclusions of the work, but simply reports progress. On the completion of the new building for this department work will be undertaken with certain diseases of live stock prevalent in the State, such as hog cholera.

The Entomologist can never foretell the line of work he shall be called upon to do a season in advance. During the past year there have been no violent outbreaks of insects on fruit or field crops which have called for his interposition. He has issued a bulletin describing the new pests and suggesting remedies.

Professor J. D. Towar, for several years the Agriculturist of the Station, was honored, in the late winter, by the appointment to a very noteworthy position in Australia. He becomes principal of the Roseworthy College of Agriculture near Adelaide, in southern Australia. He severed his connection with us on the first of May. Professor Towar devoted himself entirely to studies related to field crops, while at the College, spending his winters at institute work. In all these several lines he succeeded to the fullest extent, and the Station and College suffered a severe loss by his departure.

At a recent meeting of the Board the Director of the Station was relieved of the institute work and the immediate charge of experiments, both in the field and with live stock, was committed to his hands. This is an arrangement in every way to be commended.

During the past year the experiments with live stock have included the feeding of a carload of steers to test the relative values of an acre of corn when stored in the silo as compared with the product of an equal area when husked, ground and the stalks shredded, or left in large shocks in the field until needed. The experiment has been written up and will be published as the next bulletin in the series. The silage showed up well, but gave no greater yield of beef in the same length of feeding period than did the ground corn and the shredded stalks. It was found that the animals did not consume the silage as rapidly, proportionately, as they did the shredded stalks; when the latter were consumed, therefore, there remained on hand something over a ton of silage. In a comparison of beet pulp with corn silage it appeared that the pulp was worth approximately half as much as the silage, ton for ton. A still later experiment showed that silage gave a good account of itself as a food wherewith to finish fattening steers.

It is proposed to duplicate this experiment the coming year and to add to the live stock work by continuing the cooperation with sugar factories and prominent farmers in the feeding of sheep and fat cattle. Last winter there were fed under the supervision of the Director and by an employe of the Station three hundred sheep near the Lansing Sugar Factory to test the value of pulp as a food for fattening lambs. It is proposed that during the coming season experiments shall be undertaken at this location and elsewhere not only to test the value of pulp but also of some of the legumes, especially cow peas and soja beans as stock foods. These experiments cost the Station little, and their results will be of value alike to the people of the State who read the bulletins and to the farmers in the immediate neighborhood of the tests who will watch the progress of the trials.

As soon as sufficient funds have accumulated in the treasury of the Experiment Station it seems especially desirable that a former experiment reported in Bulletin 166 be repeated. Dairymen are slow to appreciate the results of good feeding and care on a herd of ordinary cows. The work at the Station with record-breakers, and even with the general herd is deprecated because it is assumed that the College deals with extraordinary animals only. We have demonstrated once what can be done with a herd picked up at random. There is a strong call for a repetition of that work.

The Superintendent of the Upper Peninsula Experiment Station has presented a report of what has been accomplished there during the year. The rains have been almost continuous and while the yields of most crops have been satisfactory it has been found practically impossible to gather the cereals. The root crops have been phenomenal in yield, especially potatoes. The work of clearing progresses slowly, but the house and barn have been kept in good repair and certain additions, much needed, have been made. The season of 1902 weas early in beginning but frosts early in June have practically destroyed the fruit.

The South Haven Station now has fruit orchards in full bearing. The long-looked-for results in the comparison of varieties of stone fruits and apples are now forthcoming. Certain scale insects have made their appearance in or about these orchards, affording opportunity for study and the discovery of methods of fighting them.

Through the institutes, the mailing list keeps on increasing. This is true notwithstanding the exercise of considerable care in pruning, dropping the names of citizens who have removed or are dead. The thanks of the Station are due to the postmasters who have given us indispensable aid in this matter. The cost of printing so large an edition, now forty thousand of each bulletin, is no small item. It is a source of no small satisfaction to the College, however, to know that its work receives such wide publicity in the State and that the Station is helping so many farmers.

I cannot close this report without extending the thanks of the Board and the Station to the railroads who have granted passes to the Director, and especially to the Pere Marquette railroad, which has granted a pass which carries either the Director or any one whom he may designate to points along its lines for the purpose of carrying on experiments, investigating outbreaks of fungus or insect diseases, or assisting the farmers in other ways either by lectures or by investigation.

Respectfully submitted,
C. D. SMITH,
Director and Agriculturist.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF HORTICULTURIST.

Prof. C. D. Smith, Director:

Sir—During the past year the Station work at the College has been continued along the same lines as in previous years, and in addition considerable attention has been paid to cooperative experiments in other portions of the State.

In the Station orchards, a considerable number of the new varieties came into bearing, although, as a whole, comparatively few of the younger trees bore full crops.

The strawberries made a good growth last year and this spring showed very little injurious effect from the winter. While a few of the new sorts that reached us in poor condition did not show perfect rows, for the most part it was a very even stand and afforded means for a very satisfactory test. The new plantations of bush fruits have also made an excellent growth, and will afford an opportunity for studying several of the recently introduced sorts.

The usual variety tests of vegetables are under way, with particular attention to the potato and tomato. The early spring was quite favorable for their growth and almost perfect stands have been secured.

The building of the bacteriological laboratory has made it necessary to remove the two forcing houses belonging to the Station, but as they will be needed to continue the work of the department in vegetable forcing and for starting vegetable plants for the garden, they should be rebuilt during the coming summer. A desirable site can be found just east of the bacteriological stable, and as there will be sufficient glass from the old houses to construct one new house, by securing new glass for the other an opportunity will be afforded for comparing the results with small glass, 10 by 12, with some larger size, such as 16 by 20 inches. There is also sufficient pipe for heating both houses, if, as is recommended, the steam from the central heating plant is used. The iron posts and purlins can be used again and the ventilating sash will answer for top and side ventilators in one house.

SOUTH HAVEN SUB-STATION.

At South Haven, the work was carried on by Mr. S. H. Fulton until October, when he resigned to become horticulturist of the Georgia Experiment Station. As the work of the year was practically completed, the vacancy was not filled until March, when T. A. Farrand, who had acted as foreman under Mr. Fulton, was made superintendent, and he entered at once upon his duties, which he has performed in a thorough and painstaking manner. The report of the work done last year by Mr. Fulton was written up by him and published in bulletin during the winter.

This spring the appearance of the fruit scale upon some of the plum trees and upon one peach tree, gave an opportunity for the trial of the sulphur, lime and salt mixture, which has been so thoroughly tested in California and has recently come into favor in other states. The infested trees were thoroughly sprayed and up to the time of this report no living scapes have been found upon the trees.

This mixture seems to be even more effectual than either kerosene or whale-oil soap and, besides being less likely to injure the trees, the expense is considerably less. As the San Jose scale has been found in several places in the State, and it is probable that it is present in other localities where it has not been recognized, the merits of this mixture will undoubtedly lead to its extensive use.

THE PAN-AMERICAN EXPOSITION AND STATE FAIR.

Reference was made in the report made June 30, 1901, to the exhibits sent by the department to the Pan-American exposition. During the summer and fall months, exhibits of fruit and vegetables were sent nearly every week, in order to keep up a continuous exhibit, and similar shipments of fruit were made from the South Haven Station.

The following awards were made: For models of fruit in wax, a gold medal; for a collective exhibit of fruit, a silver medal; for an exhibit of vegetable seeds, a silver medal; for a collection of potatoes, honorable mention; for a collection of 85 varieties of tomatoes, honorable mention. For the South Haven exhibit the awards consisted of a gold medal, for a collective exhibit of fruit, and honorable mention for an exhibit of edible nuts.

In September the American Pomological Society held its biennial session at Buffalo and special exhibits were sent. For the peaches, grapes and plums from the South Haven Station and apples and pears from the College bronze medals were secured.

At the State Fair, at Pontiac, collective exhibits of fruit were made as in previous years, and in addition some eighty varieties each of tomatoes and potatoes, besides a variety of other vegetables were shown. Owing to the illness of the regular superintendent, my assistant, Mr. M. L. Dean, was asked to take charge of the horticultural hall, including all of the exhibits of fruit and flowers, and he spent one week in this capacity. Under his direction a very creditable exhibit was made and his duties were performed to the satisfaction of the exhibitors and the officials of the fair.

In addition to arranging and caring for the College exhibit, Mr. Fulton and the writer acted as judges in this department.

COOPERATIVE EXPERIMENTS.

In my last report, reference to a line of experiments that were being carried on in the orchard of C. E. Hadsell of Troy, was made. The season was quite favorable to the growth of the trees and no difference was perceptible between those that were cultivated and those left in sod, nor did the manure and fertilizers have any appreciable effect, except where it was applied to the sod and there the effect was quite marked. Considering the condition of the trees the previous year, the crop of fruit secured was very satisfactory. Many of them bore full crops and most of them had at least a half crop. The fruit was quite free from scab and contained very few insects, while the foliage showed no injury from canker worms or tent-caterpillars. The apples showed excellent keeping qualities, and owing to their freedom from insect and other troubles brought the highest price in the market.

The experiment is being continued this year along the same lines as last with equally good prospects for success. In fact, as a result of the treatment given last year, the trees are making a much better growth, and nearly all of them have set a full crop of fruit. While neighboring unsprayed orchards had the foliage entirely eaten off by canker worms no signs of their work could be detected in the Hadsell orchard, and up to the time of writing no injury from scab or codling moths was apparent.

In Lenawee county, the work was taken up in a number of orchards, and experiments in tillage, spraying and the use of fertilizers are being carried on. At South Haven, in addition to the work being done at the sub-station, experiments with fertilizers on both apple and peach orchards are under way.

The results that have been secured from the sending out of trees and plants for trial, have not been generally satisfactory, as very few reports have been received, and in many cases the plants died or the labels were lost so that no report could be made.

For the future it is proposed to confine this work to a few localities where a general supervision can be kept. With this end in view only a few collections of trees, strawberry plants and potatoes were sent out this spring.

During the year a report of the work at the South Haven sub-station and bulletins giving the results of the variety tests of strawberries and of garden vegetables were issued. A revised spraying bulletin was also published.

The correspondence that has come to the department has required a large amount of time, as many of the letters contained a dozen or more questions, some of which could not be answered off-hand. In numerous instances it has been possible to refer the writers to bulletins that have been issued by this or other experiment stations, for a fuller treatment of the subject than could be given in a letter. The Farmers' Bulletins of the U. S. Department of Agriculture, have been found especially valuable for this purpose.

Although no regular press bulletins have been published during the year the same purpose has been, when letters have been received that ask for information along topics that are of especial interest to the general public, by sending copies of the answers to a number of the papers that circulate in sections where the information will be most valuable.

L. R. TAFT,
Horticulturist.

AGRICULTURAL COLLEGE, MICH.,
July 31, 1902.

REPORT OF THE BACTERIOLOGIST AND HYGIENIST.

Director C. D. Smith:

For the past year we have been concerned with a study of "Aeration of Milk," and the results are now in a process of publication. It is not necessary to enter into a discussion of the work in this place unless it is pertinent to briefly explain the character of the investigation. Our efforts may be considered persistent in seeking the fundamental facts underlying the process. To accomplish this technical science became an essential weapon, consequently our work appears somewhat difficult for perusal by dairymen who are not trained scientifically. This difficulty I have endeavored to overcome by giving the principle practical results in popular form. What else is of worth will eventually seek the light in popular dress and the minds of the least trained in science will learn the facts. The studies heretofore have been scarcely analytical and have thus fallen short of ascertaining the problems involved. Too frequently this is the case with many of our agricultural experiments. Popular en masse experiments are generally unreliable unless preceded by thorough analysis through experimentation. A simple tickling of the fancy must be regarded as reprehensible. Knowledge cannot come without effort from him who seeks, and be poured down as a glass of lemonade.

The routine work of this department is growing to that degree which requires much attention. Such work keeps us in touch with the needs of the State, consequently we trust that it will redound to the benefit of all concerned. Many specimens find their way to this laboratory during the course of the year.

The generous granting of a new laboratory to this department by the Board will materially broaden the scope of the experimental work which heretofore has been very limited from necessity. The department as a whole keenly appreciates the significance of such a liberal grant to the science of bacteriology.

I deem it a great privilege to acknowledge the conscientious assistance of Mr. S. F. Edwards and C. T. Burnett.

Most respectfully submitted,
CHARLES E. MARSHALL.

Agricultural College, Mich.,
June 30, 1902.

REPORT OF THE CONSULTING ENTOMOLOGIST.

Prof. C. D. Smith, Director:

Dear Sir—Following is a brief account of the work done by the Department of Entomology of the Experiment Station during the year ending June 30, 1902:

During the year one bulletin (No. 200) was issued by this office. The correspondence has steadily increased until at the present time it demands considerable time. Several trips were taken to investigate questions bearing on the work of injurious insects. A trip was made to South Haven to investigate the peach-borer, and one to Ypsilanti to investigate certain insects injuring the shade and fruit trees.

The weather conditions during this season have produced quite a change in the insect life and depredations. The fall of 1901 was considerably earlier than that of 1900 and 1899. This, together with the favorable moist spring, in 1902, has given the wheat a start and kept the hessian fly down so that the outlook for wheat is considerably improved. All this time the parasites of the fly are multiplying, reducing the depredations of their enemies—the flies. It appears that the fly is on the decline, and the past history of the pest shows that it appears and disappears in regular periods of years, like waves; the prospect is very encouraging.

An outbreak of a peculiar kind occurred in June. I refer to the coming of the 17-year locust (*Cicada septendecem*). This insect lives for the long period of seventeen years underground, feeding on the roots of trees, and then comes up into the air for two or three weeks to lay eggs and utter its song in the tree tops, unless unfortunate enough to be picked up by some turkey, sparrow or other creature. The newspapers, unfortunately, contained many sensational warnings of the coming of this almost harmless creature and the farmers of the State became somewhat scared. The writer made an effort to reassure the people by explaining that the insect is almost harmless. The only damage that it does is to puncture twigs in order to lay its eggs. Sometimes in the case of young fruit trees, the result is an injury, but in most cases the result is merely a pruning from which the tree recovers quickly. The insect appeared in only a few counties in the southern part of the State.

The wet spring has brought about another change in the insect population and depredation, viz: Grasshopper and flea-beetles and all insects which flourish in hot, dry weather, have not been in evidence but plant-lice on rose, corn, potato, cucumber, peas, maple and on many other plants have had full swing.

Mosquitoes have been worse than in years before, and especially in places where they usually are not to be seen at all. In many localities where they are almost unknown as a rule, they swarm this year. An experiment has been commenced at the College, the object of which is to find out some facts about the habits of mosquitoes and to test the efficiency of petroleum against the larval and pupal stages. An oil known as light fuel oil, a product of petroleum, has been used on many ponds and pools, spraying it on at the rate of one ounce to fifteen square feet of water. The result has been perfectly satisfactory so far as its effect on the mosquitoes is concerned, as all of them are killed, but unfortunately, the insects drift with the wind or fly to some distance, thus infesting the College grounds in spite of the care observed. The College is surrounded with many marshes and it is quite likely that some of these will have to be drained before very effective work can be done. The results of this work will be published more in full at a later date.

Early in the spring it was found that much damage to young clover had resulted from field mice, which ate off the stems at the crown. At the request of Director Smith the subject was investigated and remedies were proposed. It is hoped that during the coming fall some experiments may be tried here on the grounds.

Several insect diseases of considerable importance have been at work, viz: A new species of Isaria on Lecanium longulum in the greenhouse, a disease on the clover-leaf beetle larva, a disease on the seventeen-year locust, and one on the plant-louse on potato. All these are of first class importance and have considerable influence on the damage done by their hosts.

One week was spent in the winter in lecturing at farmers' institutes.

Respectfully submitted,
R. H. PETTIT,
Entomologist.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

REPORT OF THE CONSULTING VETERINARIAN.

To Director C. D. Smith:

SIR—As consulting veterinarian for the Experiment Station I have the honor to present the following report:

As in past years the greater part of my work has been in replying to letters received relative to the diseases of live stock. Where the letters referred to diseases which had the appearance of being contagious, and hence would need quarantine regulations, they were forwarded to the Live Stock Sanitary Commission. There were comparatively few of these, most of the letters referred to some sporadic disease. Many of these were received from localities where there were no veterinarians and many times we were able to make suggestions that proved of value to the writers.

From a number of places in the State letters were received with regard to an apparent contagious inflammation of the eyes, affecting more especially cattle, but at times sheep also. Where treatment was begun early the great majority responded to the dusting into the eye two or three times a day a powder composed of equal parts of finely pulverized boracic acid and calomel.

The parasitic diseases affecting the digestive organs of sheep have caused losses the same as in past years. In case of tape worms marked benefit has been derived from administering, after twelve hours of fasting, a mixture composed of the following: Aetherial extract of male fern one teaspoonful, pulverized areca nut one to two teaspoonfuls, turpentine one teaspoonful, new milk four ounces, mix thoroughly by shaking and give as a drench. It is also well to follow this in three or four hours with a cathartic composed of three or four ounces of epsom salts dissolved in water, after which food may again be given.

As to the stomach worm reports are conflicting as to the effects of various lines of treatment, some report marked benefit from the use of gasoline, while in other cases it seems to fail of producing the desired result. We hope during the coming year to carry on some experiments with these parasitic diseases which will prove of value to the flock owners of the State.

Respectfully submitted,
GEO. A. WATERMAN.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1902.

SUMMARY OF THE METEOROLOGICAL OBSERVATIONS AT THE MICHIGAN AGRICULTURAL COLLEGE FOR 1901.

Months.	Mean daily temperature in open air.	Percentage of humidity, saturation—100.	Pressure of vapor of water in air.	Height of barometer reduced to temperature of 32° F.	Percentage of cloudiness.	Self-registering thermometers.		Amount of rain or melted snow in inches.	Snowfall in inches.	Thunderstorms.
						Maximum.	Minimum.			
January	23.45	96.8	.132	29.051	71.7	27.1	13.9	1.51	12.00	0
February	14.38	100.	.090	29.068	55.5	23.8	1.8	1.81	18.30	0
March	32.49	94.7	.171	28.901	63.8	39.3	22.9	2.94	6.00	2
April	47.78	83.6	.292	29.164	44.2	58.0	34.7	2.16	.50	0
May	57.42	87.4	.376	28.967	52.9	66.4	43.9	2.36	00	4
June	69.04	89.2	.662	29.049	37.2	79.9	56.2	3.57	00	5
July	76.32	90.6	.819	29.057	25.1	86.1	62.1	5.08	00	11
August	69.29	90.8	.667	29.106	39.0	79.7	56.6	2.49	00	5
September	62.67	90.5	.526	29.135	35.8	73.4	50.0	1.67	00	0
October	51.13	88.9	.357	29.169	29.1	62.0	37.2	4.61	00	1
November	34.53	91.5	.191	29.168	61.7	41.3	24.4	1.21	1.30	0
December	24.25	96.52	.138	29.099	55	28.96	13.42	2.815	3.95	0
Year	46.98	91.71	.3684	29.161	47.58	55.5	34.75	32.225	42.05	28

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
T 1.....	11	17	7	11⅔	100	100	100	.071	.094	.060	29.440	29.458	29.546	29.481
W 2.....	7	13	—5	5	100	100	100	.060	.078	.035	29.561	29.636	29.699	29.632
T 3.....	—9	19	12	7⅓	100	100	100	.029	.103	.075	29.690	29.595	29.496	29.594
F 4.....	23	33	23	26⅓	100	89	100	.123	.175	.123	29.311	29.320	29.439	29.357
S 5.....	3	19	5	9	100	100	100	.050	.103	.055	29.547	29.513	29.489	29.516
S 6.....	23	36	33	30⅔	100	81	100	123	.186	.188	29.234	29.196	28.964	29.131
M 7	29	33	30	30⅔	100	89	89	.160	.175	.155	29.194	29.244	29.241	29.226
T 8.....	32	42	36	36⅔	100	100	100	.181	.267	.212	28.980	28.762	29.012	28.918
W 9.....	25	27	27	26⅓	100	100	100	.135	.147	.147	29.349	29.259	29.159	29.256
T 10.....	33	36	30	33	100	90	100	.188	.199	.167	28.742	28.855	29.047	28.881
F 11.....	25	27	26	26	100	100	100	.135	.147	.141	29.025	28.871	28.804	28.900
S 12.....	25	31	18	24⅔	100	89	100	.135	.155	.098	28.975	29.055	29.181	29.070
S 13.. ..	21	31	28	26⅔	100	100	100	.113	.174	.153	29.125	29.028	28.998	29.050
M 14....	34	35	35	34⅔	89	95	90	.175	.190	.183	28.733	28.603	28.707	28.681
T 15.....	34	36	39	36⅓	89	90	91	.175	.191	.216	28.732	28.694	28.489	28.638
W 16.....	32	28	25	28⅓	89	100	100	.162	.153	.135	28.442	28.534	28.697	28.558
T 17.....	19	23	17	19⅔	100	93	100	.103	.112	.094	28.540	28.888	29.005	28.811
F 18.....	12	20	9	13⅔	100	92	100	.075	.102	.065	29.129	29.025	29.153	29.102
S 19.....	—3	9	10	5⅓	100	100	100	.038	.065	.068	29.537	29.648	29.509	29.565
S 20.....	33	45	42	40	89	78	76	.175	.260	.228	29.138	29.044	28.986	29.056
M 21.....	42	34	23	36⅓	92	90	100	.254	.183	.123	28 824	29.058	29.385	29.089
T 22.....	15	30	27	24	100	89	100	.086	.155	.147	29.403	29.320	29.289	29.337
W 23.....	28	33	34	31⅔	100	89	100	.153	.175	.196	29.088	28.951	28.862	28.967
T 24.....	32	30	24	27⅔	100	89	100	.181	.155	.113	28.733	28 697	28.848	28.759
F 25.....	21	24	14	19⅔	100	100	100	.113	.129	.082	29.083	29.176	29.248	29.169
S 26.....	20	21	24	21⅔	100	100	100	.108	.113	.129	29.113	28.913	28.787	28.938
S 27.....	27	28	24	26⅓	100	100	100	.147	.153	.129	28.619	28.584	28.620	28.608
M 28.....	19	20	16	18⅓	100	100	100	.103	.108	.090	28.634	28.717	28.828	28.726
T 29.....	16	25	20	20⅓	100	100	100	.090	.135	.108	28.881	28.867	28.917	28.888
W 30.....	13	18	10	14⅓	100	100	100	.078	.098	.068	28.916	28.872	28.905	28.898
T 31.. ..	8	21	15	14⅔	100	100	100	.063	.113	.086	28.847	28.764	28.750	28.787
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	23.45	98.3	93.9	98.3	.122	.148	.125	....	....	....	29.051
Average..	......	......	......	......	96.8			.132			....	....	....	....

JANUARY, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
90	St.	30	Cir. Cu.	....	....	w	....	w	8	w	8	17	3	....	....	....	....
60	Cir. Cu.	....	....	....	....	n w	9	n w	16	n w	4	15	—11	....	....	....	....
....	....	10	Cir.	....	....	s	4	s	11	s	7	23	—9	....	....	....	....
100	St.	100	St.	60	Cir.St.	s w	9	s w	5	n e	5	33	3	....	....	....	....
....	....	....	....	....	....	n e	4	e	4	s e	4	23	4	....	....	....	....
100	St.	100	St.	100	St.	s w	8	s w	8	s w	8	36	22	1 p. m.	*	.02	.20
100	St.	100	St.	100	St.	n w	5	w	4	s w	9	33	28	....	....	....	....
100	St.	100	Nim.	100	St.	s e	10	s	13	s w	8	43	24	12 m.	9 p. m.	.08	....
80	St.	100	St.	100	St.	n	5	n e	14	e	15	33	24	6 p. m.	§	....	....
100	St.	100	St.	100	St.	s w	2	w	12	n w	3	38	24	....	1 p. m.	.52	3.00
100	St.	100	St.	100	St.	e	6	n e	8	n e	2	28	24	*	9 p. m.	.40	4.00
100	St.	80	Cu. St.	....	....	w	20	w	16	w	9	32	10	....	....	....	....
100	St.	90	St.	100	St.	s e	5	s w	8	s w	9	34	20	....	....	....	....
100	St.	100	St.	100	St.	s e	9	s	7	s	7	36	27	*	12 m.	.03	.30
100	St.	100	St.	100	St.	s w	9	s	7	s	10	44	30	....	....	....	....
100	St.	90	St.	100	St.	w	20	w	20	n w	10	32	18	†	9 p, m.	Trace	Trace
100	St.	50	Cir.St.	100	St.	n w	8	n w	14	n w	8	24	10	Snow.	Snow.	.01	.10
100	St.	100	St.	100	St.	w	5	s w	12	w	13	24	—4	9 a. m.	9 p. m.	.10	1.00
10	Cir.	20	Cir.	....	....	s w	2	s	5	s	8	33	—3	....	....	....	....
10	Cir.	....	....	....	....	s w	21	s w	17	s w	16	46	33	....	....	....	....
100	St.	100	Cu. St.	....	....	s w	12	n w	16	n w	6	42	13	....	....	....	....
....	....	10	Cir.	20	Cir.	s w	4	s w	4	s w	5	31	15	....	....	....	....
100	St.	100	St.	100	St.	s	7	s	7	s	8	37	27	‡	*	.03	.30
80	Cu. St.	100	St	100	St.	w	6	n w	8	w	11	32	19	....	....	....	....
100	St.	80	Cir.St.	....	....	n	7	n	5	n	0	26	10	....	....	....	....
100	St.	100	St.	100	St.	s	3	s w	7	s w	2	27	19	11 a. m.	9 p. m.	.15	1.50
100	St.	100	St.	100	St.	w	4	n w	11	n w	5	30	18	*	3 p. m.	.04	.40
60	Cir.St.	90	St.	100	St.	n w	6	n w	12	n w	5	22	15	3 p. m.	9 p. m.	.02	.20
100	St.	100	St.	100	St.	s	5	s w	6	w	0	26	12	*	9 a. m.	.01	.10
80	St.	10	Cir.	100	St.	s e	2	w	5	s w	1	19	0	6 p. m.	*	.01	.10
30	Cir.St.	30	Cir.	100	St.	s w	9	s w	16	s w	1	22	7	4 p. m.	9 p. m.	.10	1.00
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
77.4	....	70.6	....	67.1	....	....	....	....	....	....	....	27.1	13.9	....	....	1.51	12.00
			71.7			....	....	....	....	....	....	....	....	....	....	....	....

* In night. † Snow 1 p. m. ‡ 12 noon. § Snow and rain.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
F 1.....	11	15	11	12⅓	100	100	100	.071	.086	.071	28.840	28.963	29.123	28.975
S 2.....	7	24	19	16⅔	100	100	100	.060	.129	.103	29.268	29.183	29.173	29.208
S 3.....	23	27	25	25	100	100	100	.123	.147	.135	29.108	28.934	28.714	28.919
M 4.....	19	25	16	25	100	100	100	.103	.135	.090	29.082	29.207	29.380	29.223
T 5.....	5	18	14	12⅓	100	100	100	.055	.098	.082	29.467	29.418	29.413	29.433
W 6.....	13	20	11	14⅔	100	100	100	.078	.108	.071	29.319	29.236	29.368	29.308
T 7.....	8	23	5	12	100	100	100	.062	.123	.055	29.233	29.153	29.184	29.190
F 8.....	1	23	19	14⅓	100	100	100	.046	.123	.103	29.180	29.048	28.929	29.052
S 9.....	17	22	—3	12	100	100	100	.094	.118	.038	28.793	28.976	29.139	28.969
S 10.....	12	22	15	16⅓	100	100	100	.075	.118	.086	29.205	29.221	29.340	29.255
M 11.....	11	25	20	18⅔	100	100	100	.071	.135	.108	29.310	29.296	29.330	29.312
T 12.....	8	18	6	10⅔	100	100	100	.062	.098	.058	29.423	29.529	29.546	29.499
W 13.....	—3	22	9	9⅓	100	100	100	.038	.118	.065	29.430	29.259	29.231	29.307
T 14.....	—18	11	—5	—4	100	100	100	.020	.071	.035	29.210	29.135	29.120	29.155
F 15.....	—13	24	—6	1⅔	100	100	100	.025	.129	.033	29 080	28.997	28.950	29.009
S 16.....	10	27	17	18	100	100	100	.068	.147	.094	28.798	28.785	28.869	28.817
S 17.....	24	28	27	26⅓	100	100	100	.129	.153	.147	28.825	28.621	28.598	28.681
M 18.....	23	32	17	26	100	100	100	.160	.181	.094	28.831	28.836	28 941	28.869
T 19.....	17	22	14	17⅔	100	100	100	.094	.118	.082	28.878	28.881	28.989	28.916
W 20.....	19	21	13	17⅔	100	100	100	.103	.113	.078	28.940	28.949	29.008	28.966
T 21.....	3	23	9	11⅔	100	100	100	.050	123	.065	29.001	28.922	28.905	28.944
F 22.....	12	11	5	9⅓	100	100	100	.075	.071	.055	28.864	28.922	29.003	28.930
S 23.....	3	16	6	8⅓	100	100	100	.050	.090	.057	28.952	28.930	28.936	28.939
S 24.....	11	23	13	15⅔	100	100	100	.071	.123	.078	28.797	28.760	28.736	28.764
M 25.....	9	33	20	20⅔	100	100	100	.065	.188	.108	28.779	28.721	28.825	28.775
T 26.....	17	20	6	14⅓	100	100	100	.094	.108	.057	28.952	28.972	29.090	29.005
W 27.....	9	19	2	10	100	100	100	.065	.103	.048	29.125	29.129	29.278	29.177
T 28.....	—4	25	9	10	100	100	100	.036	.135	.065	29.377	29.307	29.259	29.314
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means.....	......	......	......	14.38	100	100	100	.073	.121	.077	....	....	....	29.068
Average..	......	......	......	......		100			.090		....	....	....	....

FEBRUARY, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
60	Cir.St.	30	Cir. Cu.	100	St.	s w	4	w	9	s w	5	18	5	....	....	......	......
50	Cir.	20	Cir.St.	90	St.	s	3	s	4	s e	3	25	7	....	....	......	......
100	St.	100	St.	100	St.	e	2	n e	4	n e	12	27	18	In	night.	.90	9.00
20	Cir.	90	St.	100	St.	w	9	n w	8	n w	7	27	1	3 p. m	5 p. m.	Trace	Trace
10	Cir.	90	Cir.St.	80	St.	w	3	w	4	w	2	18	5	....	....	......	......
90	Cir.St.	80	Cir.St.	100	St.	w	2	s w	8	s w	0	22	6	1 p. m.	4 p. m.	.01	.10
80	Cir.St.	....	....	....	....	s	2	s	2	s	1	26	—6	....	....	......	......
20	Cir.	100	St.	100	St.	e	1	n e	3	e	7	24	1	8 p. m.	....	......	......
100	St.	50	Cir.	....	....	e	....	n w	....	w	....	24	—3	....	11 a. m.	.50	5.00
40	Cir.	60	Cir.St.	100	St.	s w	....	s w	8	s w	4	25	6	....	....	......	......
90	St.	100	St.	90	St.	s w	3	s w	7	w	4	24	7	9 a. m.	4 p. m.	.02	.20
....	....	....	....	....	....	w	6	w	7	n w	1	19	—6	....	....	......	......
10	Cir.	100	St.	....	....	n w	2	n e	4	n e	0	23	—18	3 p. m.	6 p. m.	.02	.20
....	....	20	Cir.St.	....	....	w	2	w	4	w	2	16	—18	....	....	......	......
....	....	....	....	....	....	s w	1	s w	2	w	....	25	—13	....	....	......	......
100	St.	100	St.	100	St.	w	....	w	4	s w	1	27	10	....	....	......	......
100	St.	100	St.	100	St.	s w	3	s e	8	s e	2	30	23	1 p. m.	7 p. m.	.25	2.50
100	St.	80	Cir.St.	....	....	w	3	w	13	e	1	33	9	....	....	......	......
40	Cir.	100	St.	....	....	w	8	w	9	w	4	22	13	9 a. m.	5 p. m.	.02	.20
100	St.	60	Cir.	20	Cir.	n w	6	n w	9	w	4	22	—7	Snow.	Snow.	.01	.10
30	Cir.	80	Cir.St.	....	....	w	1	w	9	w	1	24	3	....	....	......	......
100	St.	40	Cir.St.	50	Cir.St.	w	4	s w	12	s w	5	16	—2	*	....	......	......
20	Cir.	100	St.	40	Cir.	w	3	s w	4	s w	1	20	3	....	5 p. m.	.04	.40
80	Cir.St.	50	Cir.St.	20	Cir.	s w	8	s w	17	s w	7	25	6	8 a. m.	4 p. m.	.02	.20
....	....	70	Cir.St.	10	Cir.	s w	3	s w	9	s w	....	35	9	....	....	......	......
100	St.	100	St.	70	Cir.St.	s w	....	w	....	w	....	21	5	1 p. m.	4 p. m.	.04	.40
100	Cir.St.	90	Cir.St.	....	....	w	....	w	2	s w	4	21	—12	1 p. m.	2 p. m.	Trace	Trace
....	....	10	Cir.	20	Cir.	s w	....	s w	6	s w	2	26	—3	....	....	......	......
....	....	....	....	....	....	...	....	....	....	....	....	......	......	....	....	1.81	18.30
55.4	....	65	....	46.1	....	....	....	....	....	....	....	23.8	1.8	....	....	......	......
		55.5				....	....	....	....	....	....	......	......	....	....	......	......

---

* In night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
F 1.....	21	37	33	30⅓	100	90	100	.113	.199	.188	28.936	28.787	28.819	28.847
S 2.....	30	30	25	28⅓	100	100	100	.167	.167	.135	29.009	29.022	29.089	29.040
S 3....	27	40	34	33⅔	100	91	79	.147	.225	.155	28.662	28.470	28.817	28.650
M 4.....	30	30	18	26	89	100	100	.148	.167	.098	28.899	28.937	29.008	28.948
T 5.....	6	7	—3	3⅓	100	100	100	.057	.060	.038	29.034	29.038	29.166	29.179
W 6.....	2	16	14	10⅔	100	100	100	.048	.090	.082	29.123	29.074	29.032	29.076
T 7.....	22	36	30	29⅓	100	80	100	.118	.170	.167	29.019	28.988	29.038	29.015
F 8.....	34	36	35	55	89	100	100	.175	.212	.204	28.847	28.771	28.720	28.779
S 9.....	30	31	25	28⅔	100	100	100	.167	.167	.135	28.914	29.028	29,121	29.021
S 10.....	31	34	38	34⅓	100	100	100	.167	.196	.229	28.834	28.511	28.458	28.601
M 11.....	32	30	26	29⅓	100	100	100	.181	.167	.141	28.517	28.733	28.909	28.720
T 12.....	28	37	33	32⅔	88	81	100	.135	.178	.188	29.082	29.062	28.970	29.038
W 13.....	34	35	33	34	100	100	100	.196	.204	·188	28.607	28.550	28.570	28.576
T 14.....	33	34	30	32⅓	100	100	100	.188	.196	.167	28.553	28.670	28.790	28.671
F 15.....	25	27	19	23⅔	100	100	100	.135	.147	.103	28.919	29.032	29.211	29.054
S 16.....	18	34	30	27⅓	100	89	100	.098	.175	.167	29.244	29.188	29.134	29.189
S 17.....	32	48	32	37⅓	89	85	100	.162	.285	.181	29.029	29.053	29.053	29.045
M 18.....	43	59	33	45	92	76	100	.254	.380	.188	28.821	28.844	28.951	28.872
T 19.....	29	35	35	33	100	100	100	.160	.204	.204	29.037	28.944	28.778	28.920
W 20.....	42	32	25	33	100	100	100	.267	.181	.135	28.618	28.644	28.679	28.647
T 21.....	23	25	23	23⅔	100	100	100	.123	.135	.123	28.658	28.712	28.798	28.723
F 22.....	26	40	28	31⅓	100	82	100	.141	.203	.153	28.945	28.993	29.016	28.985
S 23.....	40	58	47	48⅓	73	82	100	.182	.394	.323	28.971	28.897	28.922	28.930
S 24.....	44	54	48	48⅔	100	93	100	.289	.390	.335	28.940	28.866	28.864	28.890
M 25.....	47	63	49	53	92	100	92	.298	.576	.322	28.673	28.496	28.559	28.576
T 26.....	40	42	37	39⅔	91	91	100	.225	.244	.221	28.577	28.567	28.659	28.601
W 27.....	30	29	28	29	89	94	100	.148	.147	.123	28.800	28.874	28.954	28.876
T 28.....	26	38	28	30⅔	87	72	100	.123	.165	.153	29.055	29.103	29.151	29.103
F 29.....	24	36	28	29⅓	86	71	100	.111	.149	.153	29.230	29.171	29.181	29.194
S 30.....	29	35	31	31⅔	88	80	89	.142	.162	.155	29.076	28.928	28.976	28.993
S 31.....	29	46	29	34⅔	88	62	88	.142	.192	.142	29.081	29.176	29.263	29.173
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	32.49	94.9	90.9	98.3	.162	.211	.139	....	....	....	28.901
Average.	......	......	......	......	94.7			.171			....	....	....	....

Thunder, March 24-25.

MARCH, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	100	St.	100	St.	s w	10	s w	14	s w	2	38	21	8 p. m.	*	.21	2.10
100	St.	100	St.	100	St.	s e	....	n e	3	e	6	31	21	....	....	......	......
100	St.	100	Cir. St.	....	....	s e	13	s w	21	w	13	47	24	....	....	......	......
90	St.	100	St.	....	....	s w	11	n w	10	n w	8	40	5	....	....	......	......
10	Cir.	100	St.	....	....	n w	18	n w	12	n w	3	10	—5	....	....	......	......
30	Cir.	80	Cir.St.	60	Cir.St.	s w	5	s w	11	s w	....	23	2	10 a. m.	1 p. m.	.01	.10
....	....	....	....	....	....	s w	12	s w	11	s	5	37	22	....	....	......	......
100	St.	100	St.	100	St.	s	5	s	3	s e	1	39	29	1 p. m.	7 p. m.	.28	......
100	St.	100	St.	....	....	n e	10	n e	8	n	4	33	24	....	....	......	......
100	St.	100	Nim.	100	Nim.	n e	7	n e	6	n e	12	39	29	*	9 p. m.	.65	......
100	St.	100	St.	10	Cir.	n w	13	n w	11	w	10	33	22	....	....	......	......
40	Cir.St.	90	Cir.St.	100	St.	s w	4	n e	3	e	7	37	27	7 p. m.	*	.25	......
100	St.	100	Nim.	100	St.	e	8	s e	....	s	....	37	30	7 a. m.	....	......	......
100	St.	100	St.	100	St.	s w	....	n w	....	n e	3	37	24	....	11 a. m.	.40	.30
100	St.	40	Cir.	....	....	n e	6	n e	3	n	2	30	9	....	....	......	......
....	....	80	St.	30	Cir.	s w	2	s w	....	w	....	34	18	....	....	......	......
....	....	....	....	....	....	w	4	w	6	w	4	48	31	....	....	......	......
10	Cir.	....	....	50	Cir.St.	s w	6	s w	....	n e	....	59	27	....	....	......	......
100	Nim.	100	St.	100	St.	n e	....	e	....	e	....	42	29	7 a. m.	8 p. m.	.10	......
100	St.	100	St.	20	Cir.St.	s	....	s w	12	w	4	42	22	*	2 p. m.	.13	......
100	St.	100	St.	100	St.	s w	8	s w	16	s w	10	27	20	*	†	.05	.50
10	Cir.	20	Cu.	....	....	w	6	s w	8	s w	3	41	25	....	....	......	......
....	....	100	St.	100	St.	s e	6	s e	7	e	2	58	39	7 p. m.	....	......	......
100	Nim.	100	St.	100	St.	s e	1	s e	4	s e	1	54	43	6 p. m.	10 a. m.	.13	......
30	St.	30	Cir.	40	Cir. Cu.	s e	3	s w	12	s w	18	68	36	1 p. m.	7 a. m.	.68	......
100	St.	100	St.	100	St.	s w	4	s w	4	s w	6	44	28	6 p. m.	*	.05	......
100	St.	100	St.	60	Cu. St.	w	3	n w	....	n w	3	31	22	....	....	......	......
10	Cu.	....	....	70	Cir.St	n w	....	n w	4	n w	3	39	19	....	....	......	......
50	Cu.	....	....	10	Cir.	n w	2	n w	4	n	1	39	22	....	....	......	......
100	St.	100	St.	100	St.	e	8	e	8	e	5	35	24	....	....	......	......
....	....	....	....	...	....	n e	3	n e	5	n e	2	47	20	....	....	......	......
....	....	....	....	....	....	....	....	....	....	....	....	......	......	....	....	2.94	6.00
65.8	....	72.3	....	53.2	....	....	....	....	....	....	....	39.3	22.9	....	....	......	......
			63.8			....	....	....	....	....	....	......	......	....	....	......	......

* In night. † Snow, 10 p. m.

METEOROROGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
M 1.....	38	52	38	42⅔	72	60	81	.165	.232	.186	29.364	29.288	29.246	29.299
T 2.....	37	40	33	36⅔	71	73	100	.157	.182	.188	28.998	28.856	28.838	28.897
W 3.....	35	44	30	36⅓	90	76	100	.183	.218	.167	28.841	28.890	28.990	28.907
T 4.....	38	55	40	47⅓	54	68	82	.123	.295	.203	29.034	28.929	28.937	28.967
F 5.....	40	55	44	46⅓	91	74	100	.225	.321	.289	28.874	28.687	28.581	28.714
S 6.....	39	41	38	39⅓	100	91	100	.238	.235	.229	28.575	28.692	28.878	28.715
S 7.....	43	44	43	43⅓	83	76	83	.231	.218	.231	28.997	29.051	29 126	29.058
M 8.....	37	49	36	40⅔	81	71	90	.178	.247	.191	29.232	29.237	29.358	29.276
T 9....	38	57	43	46	72	69	75	.165	.322	.209	29.450	29.408	29.441	29.433
W 10.....	40	54	35	43	73	67	100	.182	.282	.204	29.548	29.503	29.534	29.528
T 11....	41	57	36	44⅔	82	63	90	.212	.295	.191	29.498	29.411	29.391	29.430
F 12.....	42	55	44	47	74	68	76	.199	.295	.218	29.333	29.246	29.159	29.246
S 13.....	46	59	48	51	77	70	92	.238	.352	.310	29.066	28.997	29.030	29.031
S 14.....	37	63	43	47⅔	90	72	92	.199	.399	.254	29.004	28.984	19.080	29.023
M 15.....	43	61	47	50⅓	92	83	92	.254	.442	.298	29.146	29.147	29.208	29.167
T 16.....	47	64	53	54⅔	85	73	80	.273	.433	.321	29.247	29.130	29.064	29.147
W 17.....	54	56	41	50⅓	80	100	100	.335	.449	.257	28.891	28.846	28.851	28.863
T 18.....	33	36	32	33⅔	100	90	89	.188	.191	.162	28.889	29.079	29.241	29.070
F 19.....	33	41	32	35⅓	80	82	89	.150	.212	.162	29.338	29.321	29.366	29.342
S 20.....	33	44	38	38⅓	89	76	81	.168	.218	.186	29.368	29.272	29.249	29.296
S 21.....	34	37	38	36⅓	89	100	100	.175	.221	.229	29.043	28.992	28.917	28.984
M 22.....	39	51	45	45	100	86	100	.238	.321	.300	28.908	29.007	29.093	29.003
T 23.....	46	58	49	51	100	88	100	.311	.423	.348	29.132	29.111	29.187	29.143
W 24.....	53	59	49	53⅔	86	88	100	.348	.439	.348	29.195	29.175	29.230	29.200
T 25.....	53	65	47	55	86	78	100	.348	.483	.323	29.253	29.218	29.270	29.247
F 26.....	56	71	56	61	75	71	87	.336	.537	.376	29.342	29.293	29.305	29.313
S 27.....	54	74	54	60⅔	74	67	100	.308	.568	.418	29.455	29.425	29.468	29.449
S 28.....	54	77	51	60⅔	67	65	100	.282	.601	.374	29.563	29.552	29.528	29.548
M 29.....	61	81	55	65⅔	83	66	100	.442	.704	.433	29.533	29.488	29.382	29.468
T 30.....	63	81	64	69⅓	83	66	89	.460	.704	.529	29.265	29.157	29.081	29.168
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means.....	......	......	......	47.78	82.6	75.9	92.3	.244	.361	.271	....	....	....	29.164
Average..	......	......	......	......		83.6			.292		....	....	....	....

APRIL, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
....	....	....	....	80	Cir.St.	n e	4	n e	5	e	3	53	33	....	....	......	......
100	St.	100	St.	100	Nim.	e	8	n e	7	n e	5	42	31	1 p. m.	*	Trace	......
100	St.	100	St.	....	....	n	8	n	8	n	1	47	26	....	....	......	......
...	....	....	....	....	....	n	4	n	4	n	1	57	30	....	....	......	......
10	Cir.	90	Cir.St.	100	St.	e	6	e	14	s e	8	56	37	4 p. m.	....	......	......
100	Nim.	100	St.	100	St.	n e	7	n	....	n	....	43	36	....	11 a. m.	.26	......
40	Cir. Cu.	100	St.	100	St.	n w	....	n	...	n	....	51	35	....	....	......	......
100	St.	90	Cu. St.	....	....	n w	....	n	7	n	5	51	29	....	....	......	......
....	....	....	....	....	....	n	2	n	7	n	2	59	29	......	....	......	......
....	....	....	....	....	....	n e	....	n e	....	n e	....	54	25	....	....	......	......
....	....	....	....	....	....	n e	....	n e	....	n	....	58	26	....	....	......	......
10	Cir.	100	St.	100	St.	s e	....	s e	6	s e	2	59	40	....	....	......	......
60	Cir,St.	90	St.	....	....	e	3	n e	5	n e	4	62	33	....	....	......	......
100	St.	60	Cu. St.	....	....	n e	1	n e	3	n	5	64	35	....	....	......	......
100	St.	60	Cu.	40	St.	s	4	s	2	s e	3	63	33	3 p. m.	5 p. m.	.01	......
....	....	80	Cu. St.	100	St.	s e	6	s e	13	s e	10	65	47	*	....	.20	......
100	St.	100	Nim.	100	Nim.	s	12	s	8	s	3	58	32	9 a. m.	....	......	......
100	St.	100	St.	40	Cir.St.	n w	5	n w	7	n w	4	38	23	....	11 a. m.	.82	.50
10	Cir.	80	Cir. Cu.	....	....	n	2	n	....	n	....	44	28	....	....	......	......
20	Cir.	40	Cir.	40	Cir.St.	n e	....	n e	11	n e	6	47	25	....	....	......	......
100	Cu. St.	100	Nim.	100	Nim.	n e	9	n e	11	n e	8	40	31	10 a. m.	....	......	......
100	Nim.	100	Cu. St.	....	....	n e	7	n e	5	n e	3	52	38	3 p. m.	9 a. m.	.67	......
100	Nim.	30	Cir. Cu.	100	St.	n e	5	n e	4	n e	3	59	44	....	8 a. m.	.12	......
....	....	100	Cu. St.	10	St.	n w	5	n	5	n	2	62	38	5 p. m.	8 p. m.	.08	......
....	....	10	Cir.	....	....	n	4	n	5	n e	1	68	39	....	......	......	......
....	....	....	....	....	....	n e	2	n e	3	n e	8	72	38	....	....	......	......
....	....	....	....	....	....	n e	5	e	5	s e	3	76	38	....	....	......	......
....	....	....	....	....	....	s e	2	e	3	e	....	77	41	....	....	......	......
....	....	....	....	20	Cir.	s	3	s	3	s	2	83	48	....	....	......	......
30	Cir.	30	Cir.	20	Cir.	s w	5	s w	8	s w	5	81	53	....	....	......	......
....	....	....	....	....	....	....	....	....	....	....	....	......	.....	....	....	2.16	.50
39.3	....	55.0	....	38.3	....	....	....	....	....	....	....	58.0	34.7	....	....	......	......
44.2						....	....	....	....	....	....	......	......	....	....	......	......

---

* In night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
W 1.....	57	76	64	65⅔	82	77	89	.410	.691	.529	29.123	28.988	28.908	29.006
T 2.....	68	79	52	66⅓	79	74	93	.543	.704	.361	28.761	28.608	28.964	28.778
F 3.....	47	64	43	51⅓	85	67	92	.273	.403	.265	29.259	29.276	29.342	29.292
S 4.....	55	73	50	59⅓	74	72	93	.321	.581	.335	29.320	29.334	29.202	29.285
S 5.....	58	79	59	65⅓	76	62	76	.365	.612	.380	29.110	28.980	28.915	29.002
M 6.....	61	72	61	64⅔	77	66	94	.413	.524	.505	28.895	28.834	28.852	28.860
T 7.....	57	70	58	61⅔	100	85	100	.466	.621	.483	28.798	28.791	28.829	28.806
W 8.....	58	66	52	58⅔	100	100	100	.483	639	.388	28.802	28.777	28.845	28.808
T 9.....	54	63	59	58⅔	100	94	100	.418	.543	.500	28.890	28.857	28.869	28.872
F 10.....	59	68	56	61	94	85	100	.469	.577	.449	28.872	28.849	28.844	28.855
S 11....	50	59	52	53⅔	100	76	79	.361	.380	.308	28.806	28.827	28.828	28.820
S 12.....	39	46	38	40⅔	100	69	100	.238	.215	.229	28.699	28.716	28.833	28.749
M 13.....	43	54	44	47	83	80	84	.231	.335	.241	28.959	28.936	29.070	28.988
T 14.....	42	56	41	46⅓	83	81	100	.222	.363	.257	29.210	29.208	29.252	29.223
W 15.....	50	64	47	53⅔	78	67	100	.283	.403	.323	29.315	29.240	29.274	29.276
T 16....	57	72	57	62	75	72	81	.350	.559	.378	29.273	29.200	29.144	29.206
F 17....	58	77	61	65⅓	82	73	100	.394	.678	.537	29.049	28.970	28.977	28.999
S 18.....	61	66	52	59⅔	88	78	100	.473	.502	.388	28.959	28.904	28.979	28.947
S 19....	51	53	53	52⅓	100	100	100	.374	.403	.403	28.978	28.965	29.048	28.997
M 20.....	52	59	50	53⅔	93	76	100	.361	.396	.361	29.058	29.047	29.052	29.052
T 21.....	54	56	60	56⅔	93	100	94	.390	.449	.487	28.949	28.775	28.698	28.807
W 22.....	57	62	59	59⅓	87	83	94	.407	.460	.469	28.749	28.823	28.856	28.809
T 23.....	64	76	62	67⅓	73	83	100	.652	.497	.556	28.854	28.836	28.858	28.849
F 24. ...	60	57	44	53⅔	100	100	100	.518	.466	.289	28.867	29.051	29.239	29.052
S 25....	50	55	45	50	85	81	100	.309	.349	.300	29.310	29.303	29.297	29.303
S 26.....	45	55	43	47⅔	100	100	100	.300	.433	.278	29.189	29.110	29.007	29.102
M 27.....	49	66	52	55⅔	92	73	79	322	.470	.308	28.905	28.844	28.791	28.847
T 28.....	51	57	44	50⅔	86	81	100	.321	.378	.289	28.789	28.724	28.868	28.794
W 29.....	50	54	49	51	85	100	100	.309	.418	.348	28.815	28.822	28.860	28.832
T 30.....	43	60	45	49⅓	92	88	100	.269	.456	.300	28.926	28.925	28.938	28.930
F 31.....	49	61	47	52⅓	92	88	85	.322	.473	.273	28.860	28.796	28.804	28.820
Sums	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means	......	......	......	57.42	85.9	81.6	94.6	.373	.483	.371	....	....	....	28.967
Average..	......	......	......	......	87.4			.376			....	....	....	....

Thunder, May 1, 7, 8, 23.

MAY, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	20	Cir.	40	Cir.	s e	3	s	6	s	7	78	55	....	....	......	......
....	....	20	Cir. Cu.	....	....	s w	5	s w	12	n	5	81	39	....	....	......	......
....	....	....	....	....	....	n e	6	n e	5	n e	1	64	35	....	....	......	......
10	Cir.	....	....	20	Cir.	s e	4	s	5	s e	2	73	38	....	....	......	......
10	Cir.	20	Cir.	30	Cir.	s e	3	s e	3	s e	2	79	52	....	....	......	......
70	Cir.St.	100	St.	40	Cir.St.	s e	7	e	7	e	3	73	51	*	....	......	......
90	Cir.St.	60	Cir.St.	100	Nim.	e	3	s	7	s e	3	74	49	8 p. m.	7 a. m.	.01	......
90	St.	100	St.	100	St.	s	1	s	....	s e	....	69	50	†	‡	.69	......
100	St.	100	St.	100	St.	e	....	e	....	e	....	63	52	8 a. m.	6 p. m.	.24	......
100	St.	70	Cir. Cu.	....	....	s e	....	s e	....	s w	....	70	49	....	....	......	......
100	Nim.	10	Cir.	30	Cir.St.	n w	....	w	....	w	....	62	37	*	9 a. m.	.16	......
100	Nim.	60	Cu.	....	....	w	....	w	....	w	....	48	33	*	9 a. m.	.14	......
10	Cir.	30	Cir. Cu.	....	......	w	...	w	....	w	....	60	35	....	....	......	......
....	....	30	Cu.	....	....	n w	....	n w	3	n w	1	58	33	....	....	......	......
....	....	....	....	....	....	n w	2	n w	3	n w	2	67	37	....	....	......	......
....	....	....	....	....	....	s w	4	s	4	s	3	74	47	....	....	......	......
80	Al.Cu.	60	Al.Cu.	100	Nim.	s	3	s w	7	s w	1	77	52	8 p. m.	*	.07	......
10	Cu.	30	Cir. Cu.	....	....	n	2	n e	4	n	1	71	44	....	....	......	......
100	Nim.	100	St.	100	St.	n	2	n e	6	n e	12	58	45	*	6 p. m.	.02	......
100	St.	60	Cir. Cu.	10	Cir.	n e	12	n e	7	n e	7	62	47	....	....	......	......
100	St.	100	Nim.	100	St.	n e	11	n e	13	e	13	61	52	9 a. m.	7 p. m.	.29	......
90	Cu. St.	60	Cir. Cu.	90	Cu. St.	s	12	s w	12	s w	2	68	49	....	....	......	......
....	....	30	Cir. Cu.	100	Nim.	s w	5	s w	8	w	8	79	55	6 p. m.	*	.70	......
100	St.	100	St.	100	St.	n w	10	n e	12	n e	13	60	42	9 a. m.	7 p. m.	Trace	......
70	Al.Cu.	100	St.	100	Nim.	n	13	n	11	n	2	56	42	8 p. m.	....	......	......
100	Nim.	100	St.	90	St.	n	3	n	4	n	2	58	43	....	3 p. m.	.02	......
100	St.	40	Cir.	60	Cir.St.	n	4	n	10	n	9	67	48	....	....	......	......
40	Cir.	60	Cir.St.	....	....	n	14	n e	8	n e	5	59	39	....	....	......	......
20	Al.Cu.	100	Nim.	30	Cir. Cu.	n e	9	n e	3	n	1	63	36	10 a. m.	2 p. m.	.02	......
70	Cir.St.	50	Cu.	....	....	w	7	s w	7	w	4	63	40	....	....	......	....
100	St.	100	St.	....	....	w	8	w	6	w	2	62	34	....	....	......	......
....	....	....	....	....	....	....	....	....	....	....	....	......	......	....	....	2.36	......
60.0	....	55.4	....	43.2	....	....	....	....	....	....	....	66.4	43.9	....	....	......	......
52.9						....	....	....	....	....	....	......	......	....	....	......	......

* In night. † 2:30 p. m. ‡ 5 a. m., .37; in night, .32.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
S 1.....	49	51	47	49	85	100	100	.297	.374	.323	28.805	28.807	28.820	28.811
S 2.....	47	61	47	51⅔	100	83	100	.323	.442	.323	28.816	28.877	28.963	28.885
M 3.....	55	69	52	58⅔	94	70	100	.405	.496	.388	29.053	29.007	29.038	29.033
T 4.....	62	78	64	68	77	69	89	.429	.691	.529	29.058	28.976	28.994	29.009
W 5.....	74	84	68	75⅓	81	75	90	.680	.877	.612	28.951	28.875	28.878	28.901
T 6.....	67	72	57	65⅓	95	76	94	.626	.595	.436	28.948	28.972	28.997	28.972
F 7.....	53	57	45	51⅔	80	81	92	.321	.378	.275	28.965	29.051	29.078	29.031
S 8.....	46	61	46	51	92	77	100	.286	.413	.311	29.173	29.181	29.210	29 188
S 9.....	56	70	46	57⅓	87	70	100	.391	.516	.311	29.263	29.219	29.194	29.225
M 10.....	62	73	60	65	77	85	94	.429	.693	.487	29 246	29.120	29.189	29.218
T 11....	68	74	71	71	90	90	100	.612	.758	.759	29.156	29.131	29.177	29.155
W 12.....	75	89	77	80⅓	90	84	95	.785	1.149	.884	29.221	29.174	29.226	29.207
T 13.....	68	84	71	74⅓	95	79	100	.648	.923	.759	29.161	29.124	29.148	29.144
F 14.....	74	74	70	72⅔	90	100	100	.758	.839	.733	29.077	29.027	29.040	29.048
S 15.....	62	76	61	66⅓	94	86	100	.523	.772	.537	29.076	29.056	29.098	29.077
S 16.....	61	76	70	69	88	86	95	.473	.772	.695	29.073	29.057	29.036	29.055
M 17.....	65	76	61	67⅓	94	86	100	.583	.772	.537	28.981	28.964	29.016	28.987
T 18.....	67	79	65	70⅓	89	82	94	.591	.813	.583	29.051	29.027	29.023	29.034
W 19.....	66	77	62	68⅓	94	82	100	.604	.758	.556	29.051	29.034	29.038	29.041
T 20.....	65	75	64	68	89	86	100	.549	.745	.596	29.071	29.036	29.076	27.061
F 21.....	66	80	65	70⅓	84	83	100	.536	.843	.618	29.076	29.004	28.988	29.023
S 22.....	71	85	68	74⅔	95	72	95	.720	.863	.648	28.913	28.820	28.896	28.876
S 23.....	69	81	67	72⅓	90	79	95	.635	.829	.626	28.936	28.935	28.983	28.985
M 24.....	71	88	75	78	86	76	90	.644	1.010	.785	29.073	29.027	29.075	29.058
T 25.....	77	92	69	79⅓	86	81	100	.799	1.214	.708	29.127	29.126	29.211	29.155
W 26.....	77	89	75	80⅓	86	84	100	.799	1.149	.868	29.246	29.224	29.234	29.235
T 27.....	81	92	75	82⅔	87	81	100	.918	1.214	.868	29.219	29.154	29.104	29.159
F 28.....	77	88	75	80	100	80	95	.868	1.060	.826	29.039	28.932	28.866	28.946
S 29.....	75	81	61	74⅔	90	74	95	.732	.758	.648	28.849	28.944	29.032	28.942
S 30.....	72	88	75	78⅓	90	80	100	.706	1.060	.868	29.045	29.014	29.022	29.027
Sums....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	69.04	89.2	81.2	97.1	.589	.793	.605	....	....	....	29 049
Average..	......	......	......	......		89.2			.662		....	....	....	....

Thunder June 11, 12, 14, 24, 25.

JUNE, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	100	Nim.	100	Nim.	n w	....	w	....	w	....	60	44	10 a. m.	*	.40	......
100	Nim.	20	Cu.	....	....	n w	....	n w	....	w	1	63	36	6 a. m.	9 a. m.	.02	......
....	....	....	....	....	....	e	1	e	6	e	2	71	44	....	....	......	......
....	....	....	....	....	....	s	3	s	7	s	7	78	60	....	....	......	......
20	Cir.	....	....	100	St.	s w	7	s w	8	w	6	86	62	*	*	.10	......
100	St.	100	St.	....	....	s w	7	s w	9	s w	2	74	45	....	....	......	......
60	Cu.	80	Cu. St.	10	Cu.	w	8	w	11	w	3	58	36	....	....	......	......
20	Cir.	....	....	....	....	n w	6	n w	4	n w	1	65	35	....	....	......	......
....	....	....	....	....	....	e	2	e	3	e	1	74	44	....	....	......	......
10	Cir.	100	St.	100	Nim.	s e	5	s e	7	s e	4	78	56	1 p. m.	9 p. m.	.21	......
90	Cir.St.	80	Cir.St.	....	....	s e	2	s	7	s	2	82	62	†	10 a. m.	.32	......
....	....	30	Cu.	100	Cu. St.	w	3	w	5	w	3	90	64	....	....	......	......
100	St.	40	Cu. St.	40	Cir.	s	4	s	4	s w	0	85	64	*	7 a. m.	.86	......
30	Cir.	100	Nim.	60	Cir.St.	s w	1	s w	3	n e	1	87	59	‡	3 p. m.	.24	......
80	Cir.St.	80	Cir.St.	....	....	n e	3	n e	4	n e	2	77	56	....	....	......	......
90	Al.Cu.	80	Cir.St.	40	Cir.St.	e	2	s e	2	s	4	79	59	....	....	......	......
100	St.	60	Cu.	20	Cir.St.	s	3	s w	7	s w	3	79	55	....	....	......	......
....	....	30	Cu.	90	Cu. St	n w	4	n w	7	n w	2	80	56	8 p. m.	*	.23	......
....	....	30	Cu.	90	St.	n w	3	w	7	w	0	79	57	*	*	.07	......
60	Cir.St.	10	Cir.	....	....	w	1	w	2	w	0	78	54	....	....	......	......
...	....	70	Cir.St.	10	Cir.	e	4	s e	8	s e	2	81	64	2 p. m.	5 p. m.	.02	......
100	St.	10	Cu.	....	....	s w	5	s w	14	w	3	85	60	....	....	......	......
20	Cir.	10	Cu.	10	Cir.	s w	2	s w	5	w	1	82	54	....	....	......	......
....	....	....	....	100	St.	w	4	s w	4	s w	4	90	66	....	....	......	......
....	....	50	Cu.	100	Cu. St.	s w	4	s w	6	n w	2	94	62	3 p. m.	4 p. m.	.69	......
10	Cir.	10	Cir.	....	....	w	3	w	6	w	0	90	64	....	....	......	......
....	....	....	....	....	....	s w	3	s w	6	s	1	92	68	....	....	......	......
60	Cir.St.	20	Cir. Cu.	....	....	s	5	s	8	s	6	89	69	§	6 p. m.	.18	......
10	Cir.	...	....	20	Cir.	s w	8	s w	9	s w	4	82	61	*	*	.23	......
70	Cir.St.	20	Cir.	....	....	s w	6	s w	12	s w	4	90	70	....	....	......	......
....	....	....	....	....	....	....	....	....	....	....	....	......	......	....	....	3.57	......
41.0	....	37.7	....	33.0	....	....	....	....	....	....	....	79.9	56.2	....	....	......	......
37.2						....	....	....	....	....	....	......	......	....	....	......	......

* In night. † 8:30 a. m. ‡ 1:30 p. m. § 5:30 p. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
M 1.....	83	94	78	85	87	78	91	.983	1.242	.870	29.157	29.124	29.160	29.147
T 2.....	82	92	75	83	87	77	90	.950	1.160	.785	29.173	29.127	29.143	29.148
W 3.....	78	86	74	79⅓	78	84	100	.744	1.038	.839	29.115	29.022	28.964	29.034
T 4.....	96	94	70	80	91	74	100	.812	1.187	.733	28.926	28.836	28.872	28.878
F 5.....	72	90	75	79	100	80	95	.785	1.135	.826	28.852	28.762	28.854	28.823
S 6.....	73	79	64	72	85	78	94	.693	.772	.563	28.917	28.882	28.895	28.898
S 7.....	59	61	59	59⅔	94	88	94	.469	.473	.469	28.988	29.046	29.144	29.059
M 8.....	63	70	60	64⅓	83	75	100	.497	.551	.518	29.239	29.237	29.234	29.237
T 9.....	73	74	71	72⅔	77	81	100	.617	.680	.759	29.274	29.256	29.204	29.245
W 10.....	75	90	80	81⅔	81	77	87	.705	1.083	.886	29.106	29.042	29.037	29.062
T 11.....	72	81	63	72	76	83	100	.595	.873	.576	29.127	29.139	29.217	29.161
F 12.....	66	81	64	70⅓	84	79	94	.534	.829	.563	29.274	29.261	29.083	29.206
S 13.....	69	85	66	73⅓	85	75	100	.599	.909	.639	29.290	29.241	29.202	29.244
S 14.....	76	89	73	79⅓	91	80	95	.812	1.097	.771	29.195	29.154	29.096	29.148
M 15.....	80	85	76	80⅓	87	100	95	.886	1.203	.854	29.090	29.038	29.026	29.051
T 16.....	78	87	77	80⅔	91	88	100	.870	1.124	.927	28.969	28.893	28 946	28.936
W 17.....	80	93	70	81	91	78	100	.931	1.200	.733	28.962	28.942	28.999	28.968
T 18.....	74	86	73	77⅔	90	80	95	.758	.989	.771	29.029	29.044	29.092	29.055
F 19.....	71	82	67	73⅓	86	79	100	.644	.859	.662	29.153	29.095	29.136	29.128
S 20.....	75	92	71	79⅓	86	74	100	.745	1.108	.759	29.110	29.028	29.056	29.065
S 21.....	79	86	78	81	82	80	95	.813	.989	.914	29.022	29.064	28.929	29.005
M 22.....	78	87	73	79⅓	86	80	90	.827	1.024	.732	29.032	29.072	29.119	29.074
T 23.....	76	87	72	78⅓	77	76	100	691	.976	.785	29.226	29.162	29.115	29.168
W 24.....	77	85	76	79⅓	86	83	100	.799	1.003	.897	29.114	29.088	29.069	29.090
T 25.....	76	83	75	78	95	83	100	.854	.936	.868	29.072	29.032	29.016	29.040
F 26.....	64	78	70	70⅔	100	91	100	.596	.870	.733	29.117	29.086	29.095	29.099
S 27.....	76	91	76	81	91	81	100	.812	1.174	.897	29.065	28.989	28.985	29.013
S 28.....	81	89	76	82	87	84	95	.918	1.149	.854	28.936	28.920	28.956	28.937
M 29.....	72	76	74	74	100	95	100	.785	.854	.839	28.902	28.844	28.919	28.888
T 30.....	72	80	64	72	90	83	100	.706	.843	.596	28.937	28.915	29.037	28.963
W 31.....	65	75	62	67⅓	94	81	100	.583	.731	.556	29.046	29.084	29.163	29.098
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	76.32	93.2	81.4	97.1	.742	.968	.747	....	......	....	29.057
Average..	......	....	......	......		90.6			.819		....	....	....	....

Thunder, July 3, 4, 5; rain, July 9, 15, 17, 23, 24, 25, 26, 27.

JULY, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
....	....	....	....	100	St.	s	6	s	8	s	2	95	71	....	....	....	....
....	....	....	....	40	Cir. Cu.	s	5	w	8	w	3	94	69	....	....	....	....
....	....	30	Cir. Cu.	20	Cu.	s e	5	s e	9	s e	3	89	69	3 p. m.	5 p. m.	.04	....
30	Cu.	75	St.	60	St.	s e	8	s w	11	s w	6	94	64	2.30p.m	4 p. m.	.25	....
20	Cir.	....	....	....	....	s w	8	s w	14	s w	4	91	62	†	5 a. m.	2.16	....
....	....	10	Cu.	40	Cu.	s w	6	w	6	w	3	80	56	....	....	....	....
100	St.	100	St.	10	Cir.	w	....	w	....	w	....	64	49	....	....	....	....
....	....	10	Cu.	....	....	w	....	n w	....	s e	....	74	51	....	....	....	....
....	....	100	St.	100	St.	s e	....	s	7	s	7	79	64	7 p. m.	†	.14	....
....	....	....	....	40	Cir.St.	s	9	s w	4	n w	3	90	61	....	....	....	....
...	....	10	Cu.	....	....	n w	3	n e	5	n e	2	81	51	....	....	....	....
....	....	10	Cu.	....	....	e	1	e	3	e	0	82	50	....	....	....	....
....	....	....	....	....	....	e	2	e	4	e	0	85	58	....	....	....	....
....	....	10	Cu.	....	....	s e	3	s e	3	s e	1	89	64	....	....	....	....
....	....	90	Cu.Nim.	10	Cir.	s e	3	s e	2	s e	1	90	70	1.30p.m	4 p. m.	.14	....
60	Cir.	40	Cir.St.	....	....	s e	1	s w	2	s w	2	92	68	....	....	....	....
....	....	....	....	10	Nim.	s e	1	s e	1	s w	4	94	64	7 p. m.	†	Trace	....
....	....	....	....	....	....	n	4	n	....	n	....	87	56	....	....	....	....
....	....	....	....	....	....	n e	....	e	2	s	1	85	58	....	....	....	....
....	....	...	....	....	....	s	5	s	6	s w	1	98	66	....	....	....	....
60	Cir.St.	70	Cir.St.	40	Cir.St.	s w	6	w	7	w	5	89	67	....	....	....	....
....	....	....	....	....	....	n e	3	e	3	e	1	88	55	....	....	....	....
...	....	....	....	70	Cu.	e	3	e	3	s e	2	88	66	†	†	.26	....
10	Cir.	....	....	70	Cu. St.	s	8	s w	3	n w	0	87	68	†	†	.04	....
80	Cir.St.	50	Cir.St.	80	Cu. St.	w	2	w	5	n w	3	85	63	9 p. m.	†	1.38	....
100	Nim.	60	Cir.St.	40	Cir.	e	2	e	3	s e	7	80	63	†	†	.04	....
20	Cir.	40	Cir. Cu	....	....	s e	6	s w	6	w	3	91	71	1.30p.m	2 p. m.	.01	....
30	Cir. Cu.	20	Cir.	10	Cu.	n w	8	w	9	s w	3	89	71	....	....	....	....
100	Nim.	100	St.	5	Cu.	s w	6	s w	9	s w	2	80	67	†	12 a. m.	.62	....
....	....	10	Cir.	25	Cir.	s w	6	w	9	w	2	82	58	....	....	....	....
...	....	50	Cu.	....	....	s w	2	n w	7	w	2	78	52	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5.08	....
19.7	....	28.5	....	27.1	....	....	....	....	....	....	....	86.1	62.1	....	....	....	....
25.1						....	....	....	....	....	....	....	....	....	....	....	....

---

† In night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
T 1.....	58	72	58	62⅔	94	81	100	.452	.631	.483	29.143	29.125	29.101	29.123
F 2.....	62	79	67	69⅓	94	100	95	.523	.990	.626	29.131	28.707	28.878	28.905
S 3.....	60	72	64	65⅓	88	86	94	.456	.668	.563	29.044	29.080	29.144	29.089
S 4.....	59	73	55	62⅓	82	81	100	.410	.655	.433	29.217	29.191	29.258	29.222
M 5.....	58	76	62	65⅓	88	81	88	.423	.731	.491	29.258	29.243	29.244	29.248
T 6.....	58	82	64	68	88	79	100	.423	.859	.596	29 186	29.104	29.091	29.127
W 7.....	63	82	70	71⅔	94	83	85	.543	.904	.621	29.117	29.052	29.041	29.070
T 8.....	65	78	56	66⅓	89	76	100	.549	.738	.449	29.134	29.118	29.143	29.132
F 9.....	61	80	68	69⅔	94	87	100	.505	.886	.685	29.089	28.890	28.868	28.949
S 10.....	69	70	61	66⅔	90	85	88	.635	.621	.473	28.858	29.017	29.107	28.994
S 11.....	57	70	56	61	87	85	100	.407	.621	.449	29.189	29.171	19.167	29.176
M 12.....	55	80	64	66⅓	87	78	100	.376	.800	.596	29.171	29.167	29.184	29.174
T 13.....	72	83	67	67⅓	76	83	100	.595	.936	.662	29.207	29.148	29.138	29.164
W 14.....	68	90	68	75⅓	79	76	100	.543	1.010	.685	29.091	29.025	28.996	29.038
T 15.....	67	85	66	72⅔	89	75	89	.591	.909	.570	28.958	28.933	29.056	28.982
F 16.....	68	79	62	69⅔	79	78	94	.543	.772	.523	29.170	29.105	29.117	29.131
S 17.....	71	84	72	75⅔	86	83	100	.644	.969	.785	29.081	29.001	29.023	29.035
S 18.....	73	78	72	74⅓	90	91	100	.732	.870	.785	29.026	28 975	29.016	29.006
M 19.....	70	72	66	69⅓	95	95	100	.695	.745	.639	29.023	29.020	29.195	29.079
T 20.....	66	72	70	69⅓	100	95	100	.639	.745	.733	29.127	29.107	29.098	29.111
W 21.....	72	83	73	76	95	83	95	.745	.936	.771	29.083	29.036	29.063	29 061
T 22.....	75	81	68	74⅔	90	87	100	.785	.918	.685	29.060	29.014	29.053	29.042
F 23....	71	76	67	71⅓	95	91	100	.720	.812	.662	29.080	29.131	29.182	29.131
S 24.....	70	78	63	70⅓	90	86	100	.658	.827	.576	29.273	29.267	29.282	29.274
S 25:....	69	78	68	71	89	91	100	.591	.870	.685	29.277	29.261	29.187	29.242
M 26.....	69	73	62	68	95	100	100	.671	.812	.556	29.145	29.140	29.163	29.149
T 27.....	65	83	66	71⅓	94	79	100	.583	.891	.639	29.166	29.111	29.170	29.149
W 28.....	73	84	67	74⅔	81	83	100	.655	.969	.662	29.173	29.158	29.162	29.164
T 29.....	71	84	69	74⅔	90	83	100	.682	.969	.708	29.145	29.089	29.050	29.095
F 30.....	66	74	62	67⅓	100	90	100	.639	.758	.556	29.033	29.013	29.098	29.048
S 31.....	60	66	55	60⅓	91	89	100	.480	.570	.433	29.150	29.147	29.209	29.169
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	69.29	89.6	85.2	97.7	.577	.819	.603	.. ..	....	....	29.106
Average..	......	......	......	.....	90.8			.667			....	....	....	....

Thunder, August 7, 18, 22, 26, 30.

AUGUST 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
....	....	50	Cir.	....	....	n w	3	w	3	w	0	76	55	....	....	......	......
100	St.	10	Cu.	90	Cu. St.	s w	3	s w	10	s w	4	80	54	7 a. m.	9 a. m.	.14	......
60	Cu.	100	Cu.	75	Cu.	n w	3	n w	3	n w	2	74	50	....	....	.....	.....
....	....	10	Cu.	....	....	n	2	n	2	n	0	73	47	....	....	......	......
....	....	10	Cu.	....	....	n	3	n w	3	n w	1	76	48	....	....	......	....
....	....	40	Cu.	....	....	n e	2	n e	3	n e	1	82	53	....	....	......	......
....	....	50	Cu.	90	St.	s w	4	s w	3	n w	3	84	59	....	....	......	......
10	Cir.	25	Cir.	....	....	n w	5	n w	6	n w	1	79	47	....	....	......	......
90	Cu.	100	Cu.	100	St.	n w	7	n	4	n	1	82	60	......	....	......	...
80	Cu.	90	Cu.	100	St.	n w	7	n w	7	n w	2	72	51	....	....	......	...
20	Cu.	30	Cu.	....	....	n w	2	n w	2	n w	0	72	46	....	....	......	......
10	Cu.	....	....	....	....	s	3	s	2	s	0	83	53	....	....	......	......
10	Cir.	10	Cu.	....	....	s e	4	s e	3	s	1	86	56	....	....	......	......
10	Cir.	...	....	20	Cu.	s	4	s w	4	s w	1	90	58	....	....	......	......
80	Cir.St.	20	Cu.	....	....	s w	2	w	7	w	2	87	48	....	....	......	...
....	....	20	Cir.	20	Cir.	n e	1	n e	2	n e	1	81	58	....	....	......	......
....	....	60	Cu. St.	60	St.	n e	4	s e	7	s e	1	87	66	....	....	......	......
90	St.	100	St.	100	Nim.	s e	3	s e	5	s e	1	81	67	1 p. m.	*	.42	......
100	St.	100	St.	100	St.	e	2	e	2	n e	5	74	62	9 a. m.	10 a. m.	.06	....
100	St.	100	St.	....	....	s e	2	n e	3	n	1	75	65	....	....	......	......
100	St.	20	Cu.	....	....	e	2	s e	7	s e	3	85	64	....	....	......	......
20	Al.Cu.	70	Cu. St.	100	Nim.	s e	5	s w	6	s w	2	84	66	1 p. m.	*	.32	.....
80	St.	70	St.	30	Cir.St.	w	2	w	4	w	1	81	58	....	....	......	......
10	Cir.	....	....	....	....	n w	2	n w	2	n w	0	79	56	....	....	......	......
....	....	40	Cir.	60	Cir.St.	e	4	s e	3	s e	2	82	64	....	....	......	......
100	St.	100	Nim.	10	Cir.	s	2	s	2	s e	1	74	56	†	3 p. m.	.57	.....
....	....	....	....	....	....	e	1	e	3	e	1	84	58	....	....	......	....
....	....	....	....	....	....	e	2	s e	6	s e	3	85	61	....	....	......	......
....	....	60	Cu. St.	20	Cir.	s e	3	s w	5	s	2	84	62	....	....	......	......
90	St.	20	Cu.	100	St.	n w	2	n	3	n	5	78	58	4 a. m.	6 a. m.	.98	......
100	St.	90	St.	...	....	n	4	n	3	n	0	69	50	....	....	......	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2.49	.....
37.4	....	45.0	....	34.7	....	....	....	....	....	....	...	79.7	56 6	....	....	......	.....
39.0						....	....	....	....	....	....	....	.....	....	....	......	.....

---

* In night. † 9:30 a. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
S 1.....	57	74	57	62⅔	94	81	100	.436	.680	.466	29.192	29.157	29.179	29.176
M 2.....	62	77	61	66⅔	100	82	100	.556	.758	.537	29.218	29.195	29.246	29.220
T 3	62	81	64	69	94	79	100	.523	.829	.596	29.276	29.263	29.292	29.277
W 4.....	66	84	64	71⅓	89	83	100	.570	.969	.596	29.325	29.268	29.240	29.278
T 5.....	69	87	68	74⅔	90	76	100	.635	.976	.685	29.280	29.193	29.225	29.233
F 6.....	66	88	67	73⅔	89	76	100	.570	1.010	.662	29.275	29.265	29.227	29.256
S 7.....	69	87	64	73⅓	90	72	89	.635	.928	.529	29.223	29.126	29.265	29.205
S 8.....	56	64	51	57	87	89	100	.391	.529	.374	29.363	29.314	29.291	29.323
M 9.....	54	56	56	55⅓	93	100	100	.390	.449	.449	29.284	29.174	29.104	29.187
T 10.....	62	65	58	61⅔	94	100	100	.523	.618	.483	28.995	28.969	28.998	28.987
W 11.....	59	65	59	61	94	89	100	.469	.549	.500	28 995	28.949	28.835	28.926
T 12.....	68	72	69	76⅓	90	95	100	.612	.745	.708	28.639	28.653	28.840	28.711
F 13.....	57	71	56	61⅓	100	86	100	.466	.644	.449	28.807	28.934	28.962	28.901
S 14.....	57	73	67	65⅔	94	85	89	.436	.693	.591	28.995	28.868	28.703	28.855
S 15.....	67	71	64	67⅓	89	86	89	.591	.644	.529	28.670	28.748	28.831	28.750
M 16.....	60	67	56	61	88	79	100	.456	.522	.449	28.985	29.045	29.055	29.028
T 17.....	55	59	42	52	87	82	100	.376	.410	.267	28.988	29.028	29.108	29.041
W 18.....	46	51	39	45⅓	92	93	100	.286	.348	.238	29.149	29.218	29.319	29.229
T 19.....	42	54	47	47⅔	91	87	92	.244	.362	.298	29 503	29.364	29.307	29.391
F 20.....	48	53	41	47⅓	92	93	100	.310	.375	.257	29.208	29.188	29.245	29.214
S 21.....	46	65	53	54⅔	92	78	86	.286	.483	.348	29.288	29.183	29.130	29.200
S 22.....	54	77	62	64⅓	87	73	94	.362	.678	.523	29.126	29.019	29.018	29.054
M 23.....	62	80	60	67⅓	88	78	100	.491	.800	.518	29.090	29.064	29.119	29.091
T 24.....	62	73	53	62⅔	88	81	93	.491	.655	.375	29.242	29.263	29.383	29.296
W 25.....	53	68	55	58⅔	86	85	87	.348	.577	.376	29.440	29.376	29.374	29.397
T 26.....	59	81	63	67⅔	94	83	94	.469	.873	.543	29.356	29.272	29.281	29.303
F 27.....	64	81	62	69	89	74	94	.529	.787	.523	29.295	29.223	29.174	29.231
S 28	59	76	61	65⅓	88	81	100	.439	.731	.537	29.153	29.055	29.007	29.072
S 29.....	61	74	57	64	100	81	94	.537	.680	.436	28.929	28.922	29.102	28.984
M 30.....	49	66	53	56	92	84	100	.322	.536	.403	29.277	29.223	29.197	29.232
Sums.....	......	.....	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	62.67	91.4	83.4	96.7	.441	.661	.475	....	....	... .	29.135
Average..	.....	......	......	......		90.5			.526		... .	....	....	......

Frost, September 18.

SEPTEMBER, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
80	Cu. St.	20	Cir.	90	St.	n w	3	n w	5	n w	0	74	56	....	....	....	....
90	Al.Cu.	30	Al.Cu.	....	....	n w	2	n e	3	n e	0	78	51	....	....	....	....
....	....	....	....	....	....	s e	2	s w	3	w	0	83	54	....	....	....	....
....	....	....	....	....	....	s w	1	s w	2	s w	0	85	55	....	....	....	....
....	....	....	....	....	....	s w	3	s w	4	s w	1	87	57	....	....	....	....
....	....	20	Cu.	10	Cu.	s w	2	n w	2	s	1	88	58	....	....	....	....
20	Cu.	10	Cu.	100	St.	s w	2	w	4	n	4	88	50	*	6 p. m.	.08	....
80	St.	80	Al.Cu.	....	....	n e	4	n e	3	n e	1	65	48	....	....	....	....
100	St.	100	Nim.	70	Cu. St.	e	1	e	2	s e	6	63	52	8 a. m.	4 p. m.	.20	....
100	St.	100	St.	100	St.	s e	5	s w	8	w	4	69	56	....	....	....	....
100	St.	100	St.	100	Nim.	n e	2	e	2	s e	6	68	58	4 p. m.	†	.88	....
50	Cu.	60	Cu. St.	100	St.	w	8	w	6	w	3	74	51	1 p. m.	†	.28	....
....	....	....	....	....	....	w	2	w	4	w	1	72	48	....	....	....	....
....	....	50	Al.Cu.	60	Cir. Cu.	s w	4	s w	12	s e	11	77	57	4 p. m.	†	.11	....
100	St.	40	Cu.	....	....	s w	13	s w	18	s w	15	73	53	....	....	....	....
....	....	30	Cir.	90	Cir.St.	s w	16	w	14	w	9	69	44	....	....	....	....
70	Cir.St.	20	Cu.	....	....	w	7	w	21	n w	5	61	39	....	....	....	....
30	Cu.	90	Cu. St.	....	....	n w	6	w	9	w	7	55	31	4 p. m.	7 p. m.	.10	‡
....	....	100	St.	60	Cir.St.	w	1	n e	1	n e	1	56	42	†	†	.02	....
80	Cir.St.	100	St.	....	....	w	1	w	13	w	4	57	34	....	....	....	....
60	Cir. Cu.	10	Cir.	....	....	s w	5	s w	10	s	6	66	43	....	....	....	....
....	....	....	....	....	....	s	10	s	16	s	12	77	56	....	....	....	....
....	....	....	....	....	....	s	12	s w	10	s	5	81	55	....	....	....	....
....	....	....	....	90	Cu. St.	s e	1	s e	16	e	12	74	48	....	....	....	....
90	Cir.St.	....	....	....	....	e	12	e	15	e	8	74	51	....	....	....	....
....	....	....	....	10	Cir.	s	5	s	2	e	4	83	54	....	....	....	....
....	....	....	....	....	....	s e	6	s	9	s	5	82	50	....	....	....	....
30	Cir.	30	Cu.	60	Cir.St.	s	6	s	10	s e	3	77	55	....	....	....	....
80	Cir.St.	80	Al.Cu.	20	St.	s w	0	w	8	w	10	76	46	....	....	....	....
30	Cir St.	....	....	....	....	n e	4	e	4	s e	4	69	48	....	....	....	....
....	....	....	....	...	....	....	....	....	....	....	....	....	....	....	....	1.67	....
39.7	....	35.7	....	32	....	....	....	....	....	....	....	73.4	50 0	....	....	....	....
			35.8			....	....	....	....	....	....	....	....	....	....	....	....

* 4:30 p. m. † In night. ‡ Frost.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
T 1.....	61	78	60	66⅓	88	78	100	.473	.744	.518	29.075	28.886	28.877	28.946
W 2.....	48	56	40	48	100	81	100	.335	.363	.248	28.908	28.940	29.005	28.951
T 3.....	39	51	32	40⅔	91	86	100	.216	.334	.181	29.019	28.989	29.041	29.016
F 4.....	39	49	32	40	91	78	100	.216	.272	.181	29.159	29.178	29.293	29.210
S 5.....	42	59	41	47⅓	83	82	100	.222	.410	.257	29.296	29.248	29.297	29.280
S 6.....	36	59	39	44⅔	90	82	100	.191	.410	.238	29.453	29.463	29.501	29.472
M 7.....	45	72	55	60⅔	84	72	87	.251	.559	.376	29.512	29.387	29.372	29.424
T 8.....	52	75	63	63⅓	86	73	83	.334	.628	.478	29.211	29.098	29.088	29.132
W 9.....	61	63	59	61	94	100	100	.505	.576	.500	29.008	28.995	29 020	29.008
T 10.....	55	59	49	54⅓	100	94	100	.433	.469	.348	29.161	29.185	29.200	29.182
F 11.....	57	73	61	63⅔	87	81	100	.407	.655	.537	29.159	28.950	28.911	29.007
S 12.....	56	55	50	53⅔	100	100	100	.449	.433	.361	28.792	28.635	28.366	28.598
S 13.....	46	53	39	46	100	100	100	.311	.403	.238	28.754	28.843	28.963	28.853
M 14.....	43	53	43	46⅓	92	86	100	.254	.348	.278	29.071	29.049	29.140	29.087
T 15.....	45	60	50	51⅔	84	76	100	.251	.396	.361	29.142	29.063	29.150	29.118
W 16.....	43	49	42	44⅔	92	85	83	254	.297	.222	29.183	29.095	29.080	29.119
T 17.....	38	46	28	37⅓	81	84	100	.186	.262	.153	29.082	29.076	29.233	29.130
F 18.....	33	55	50	46	80	81	85	.150	.349	.309	29.302	29.114	29.023	29.147
S 19.....	53	59	37	49⅔	86	82	100	.348	.410	.221	29.027	29.243	29.412	29.227
S 20.....	32	56	37	41⅔	100	81	100	.181	.378	.221	29.495	29.447	29.448	29.464
M 21.....	42	68	47	52⅓	91	79	100	.244	.543	.323	29.336	29.354	29.313	29.334
T 22.....	52	72	57	60⅓	86	81	81	.334	.631	.378	29.296	29.248	29.243	29.262
W 23.....	59	74	51	61⅓	88	73	86	.439	.604	.321	29.084	28.972	29.120	29.059
T 24.....	39	49	34	40⅔	91	85	100	.216	.297	.196	29.295	29.318	29.381	29.331
F 25.....	33	56	36	41⅔	89	75	100	.168	.336	.212	29.416	29.311	29.265	29.331
S 26.....	46	66	52	54⅔	84	78	100	.262	.502	.388	29.165	29.072	29.122	29.120
S 27.....	37	49	37	41	90	85	100	.199	.297	.221	29.278	29.317	29.387	29.327
M 28.....	34	54	45	44⅓	89	80	92	.175	.335	.275	29.469	29.421	29.422	29.437
T 29.....	51	74	60	61⅔	93	81	94	.348	.680	.505	29.424	29.320	29.334	29.359
W 30.....	56	74	59	63	94	77	88	.420	.641	.439	29.317	29.187	29.167	29.224
T 31.....	59	64	49	57⅓	88	100	100	.439	.596	.348	29.074	28.987	29.169	29.077
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	51.13	87.5	83.1	96.1	.297	.457	.317	....	....	....	29.169
Average..	......	......	......	......		88.9			.357		....	....	....	....

Thunder, October 1.

OCTOBER, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
10	Cir.	20	Cir.	80	Cu. St.	s w	10	s	10	w	8	79	42	6 p. m.	†	.02	......
100	St.	40	Cu.	....	....	w	3	w	8	w	3	58	29	7 a. m.	10 a. m.	.03	......
....	....	30	Cu.	....	....	n w	5	n	8	n	1	52	29	....	....	......	......
....	....	50	Cu.	....	....	n	3	w	5	w	1	51	26	....	....	......	......
20	Cir.St.	....	....	....	....	s w	5	w	12	w	2	60	31	....	....	......	......
....	....	....	....	....	....	n	1	n	2	w	1	59	31	....	....	......	......
....	....	....	....	20	Cir.	w	4	s w	5	s	9	72	46	....	....	......	......
60	Cir.	30	Cir.	50	Cir.	s w	5	s w	10	s w	5	75	50	....	....	......	......
90	St.	100	St.	100	Nim.	s w	1	s w	7	s w	2	66	53	*	2 p. m.	.60	......
100	St.	80	St.	....	....	s w	4	w	5	n w	2	63	48	*	7 a. m.	.30	......
....	....	50	Cir.St.	100	Nim.	n	5	w	8	w	9	75	55	7 p. m.	....	......	......
100	Nim.	100	Nim.	100	Nim.	w	7	n w	8	n w	12	58	45	9 p. m.	9 p. m.	3.02	......
100	Nim.	30	Cir. Cu.	....	....	w	9	s w	7	s w	1	55	35	....	2 p. m.	.56	......
....	....	60	Cir. Cu.	30	Cir. Cu.	s	3	s w	10	s w	4	56	38	....	....	......	......
30	Cir. Cu.	30	Cir. Cu.	60	Cir.St.	s w	6	s w	18	s w	5	60	40	....	....	......	......
100	St.	100	St.	60	St.	n e	2	n	2	n w	3	50	30	....	....	......	......
....	....	60	Cu. St.	....	....	w	5	w	19	s w	8	47	22	....	....	......	......
70	St.	....	....	....	....	s	6	s	18	s w	12	57	33	....	....	......	......
....	....	....	....	....	....	w	10	n	9	n	4	60	27	....	....	......	......
....	....	...	....	....	....	n e	2	n w	4	w	2	56	30	....	....	......	......
....	....	....	....	....	....	s w	8	w	6	w	8	69	38	....	....	......	......
...	....	....	....	....	....	w	3	w	10	w	12	74	50	....	....	......	......
30	Cir.	....	....	....	....	w	9	w	24	n	7	74	35	....	....	......	......
20	Cir.	10	Cir.	....	....	n	6	n	4	e	3	49	26	....	....	......	......
....	....	....	....	....	....	s w	4	s w	7	s w	4	56	31	....	....	......	......
20	Cir.	50	Cir.St.	90	Cu. St.	s w	7	s w	12	w	5	66	36	....	....	......	......
10	Cir.	....	....	....	....	n e	4	n e	8	e	8	50	26	....	....	......	......
....	....	80	Cu. St.	...	....	e	10	e	11	s e	7	55	34	....	....	......	......
20	Cu.	20	Cir. Cu.	20	Cir.	s	9	s	10	s w	8	74	50	....	....	......	......
10	Cir.	10	Cir.	20	Cir.	s w	9	s w	13	s w	9	75	50	....	....	......	......
20	Cir.	100	Nim.	....	....	s w	10	s w	15	w	3	70	36	2 p. m.	5 p. m.	.08	......
...	....	....	....	....	....	....	....	....	....	....	....	......	......	....	....	4.61	......
29.7	....	33.9	....	23 6	....	....	....	....	....	....	....	62.0	37.2	....	....	......	......
29.1						....	....	...	....	....	....	......	......	....	....	......	......

* In night. † 6:30 p. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
F 1.....	43	55	32	43⅓	92	74	100	.254	.321	.181	29.189	29.219	29.305	29.234
S 2....	35	57	41	44⅓	80	75	100	.162	.350	.257	29.400	29.297	29.263	29.320
S 3.....	42	58	36	45⅓	91	82	100	.244	.394	.212	29.038	28.826	28.997	28.954
M 4.....	26	27	24	25⅔	100	100	100	.141	.147	.129	29.151	29.223	29.312	29.229
T 5.....	26	33	26	28⅓	87	89	100	.123	.168	.141	29.297	29.277	29.250	29.275
W 6.....	29	44	42	38⅓	88	84	83	.142	.241	.222	29.250	29.111	29.035	29.132
T 7.....	40	41	36	39	91	91	90	.225	.235	.191	28.862	28.964	29.173	29.000
F 8.....	25	47	43	38⅓	87	85	83	.117	.273	.231	29.294	29.166	29.135	29.198
S 9.....	35	42	27	34⅔	80	91	100	.162	.244	.147	29.279	29.380	29.504	29.388
S 10.....	25	44	37	35⅓	100	76	71	.135	.218	.157	29.545	29.452	29.268	29.421
M 11.....	50	56	55	53⅔	100	100	100	.361	.449	.433	28.948	28.771	28.678	28.799
T 12.....	36	35	32	37⅔	90	95	89	.191	.190	.162	28.892	29.009	29.091	28.997
W 13.....	32	45	32	36⅓	89	84	89	.162	.251	.162	29 026	28.960	28.986	28 991
T 14.....	32	32	28	40⅔	89	89	100	.162	.162	.153	28.932	28.924	28.912	28.923
F 15.....	30	33	30	31	89	89	100	.148	.168	.167	28.880	28.936	28.967	28.928
S 16.....	29	32	31	30⅔	100	100	100	.160	.181	.174	28.975	29.032	29.091	29.033
S 17.....	32	36	33	33⅔	100	90	100	.181	.191	.188	29.179	29.198	29.252	29.230
M 18.....	31	39	26	32	100	82	100	.174	.195	.141	29.309	29.276	29.283	29.289
T 19.....	32	37	31	33⅓	100	90	100	.181	.199	.174	29.304	29.283	29.303	29.297
W 20.....	23	38	30	30⅓	86	81	100	.106	.186	.167	29.350	29.345	29.366	29.354
T 21.....	26	44	33	34⅓	87	76	100	.123	.218	.181	29.368	29.294	29.252	29.305
F 22.....	38	42	33	37⅔	91	91	100	.208	.244	.188	29.149	29.117	29.175	29.147
S 23.....	32	35	33	33⅓	100	100	100	.181	.204	.188	29.143	29.036	29.007	29.062
S 24.....	31	34	34	33	100	89	100	.174	.175	.196	29.067	28.938	28.953	28.986
M 25.....	34	30	27	30⅓	89	100	100	.175	.167	.147	29.144	29.159	29.259	29.187
T 26.....	25	28	24	25⅔	100	87	100	.135	.117	.129	29.339	29.350	29.381	29.355
W 27.....	19	30	22	23⅔	100	89	100	.103	.148	.118	29.432	29.498	29.556	29.495
T 28.....	11	31	32	24⅔	100	100	100	.071	.174	.181	29.581	29.498	28.238	29.406
F 29.....	38	37	35	36⅔	91	100	100	.208	.221	.204	28.985	29.037	29.138	29.053
S 30.....	31	41	33	35	89	82	100	.155	.212	.188	29.129	29.048	28.950	29.042
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	34.53	92.9	88.0	93.5	.169	.221	.184	....	....	....	29.168
Average..	......	......	......	......	91.5			.191			....	....	....	....

NOVEMBER, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
....	....	....	....	....	....	s w	5	s w	12	w	1	56	26	....	....	......	......
....	....	....	....	....	....	s e	3	s e	7	s e	6	58	34	Hazy.	....	......	......
....	....	100	St.	90	St.	s e	8	s e	7	w	13	59	25	3 p. m.	7 p. m.	.13	......
100	St.	80	St.	100	St.	n w	6	n w	13	w	6	28	23	*	7 p. m.	.05	.30
60	St.	90	St.	....	....	w	2	w	4	w	5	34	20	....	....	......	......
40	Cir.St.	20	Cir.	90	St.	s w	6	s w	10	s e	12	48	29	....	....	......	......
100	St.	100	St.	100	St.	s	13	w	11	n w	12	42	22	....	....	......	......
....	....	50	Cir. Cu.	100	St.	s w	4	s w	10	s w	9	48	24	....	....	......	......
40	Cu.	70	Cu. St.	....	....	n w	5	n w	8	n	2	44	19	....	....	......	......
20	Cir. Cu.	20	Cir.	....	....	e	3	s e	11	s e	12	50	22	....	....	......	......
100	Nim.	100	Nim.	100	Nim.	s w	10	w	15	w	20	59	35	*	9 p. m.	.51	......
100	St.	100	St.	100	St.	w	10	n w	10	n w	4	38	24	....	....	......	......
40	Cir. Cu.	50	Cir. Cu.	40	Cir. Cu.	n w	4	n w	12	n w	5	46	29	....	....	......	......
20	Cu.	40	Cu.	30	Cu.	n w	5	n w	14	n w	12	38	27	12 m.	*	.03	.30
60	Cir.St.	100	St.	100	St.	n w	7	n w	6	n w	8	34	28	6 p. m.	*	Trace	Trace
50	Cir.St.	100	St.	100	St.	n w	5	n w	7	s w	4	33	28	....	....	......	......
100	St.	100	St.	100	St.	w	3	w	4	w	2	36	29	....	....	......	......
100	St.	10	Cir.	....	....	n w	2	s w	5	w	2	40	25	†	8 a. m.	.02	.20
100	St.	100	St.	80	Cir.St.	s w	2	n w	3	w	3	38	20	....	....	......	......
30	Cir.	60	Cu. St.	....	....	n w	1	n e	2	e	2	38	22	....	....	......	......
....	....	....	....	20	Cu.	s e	4	s w	10	s w	5	44	25	....	....	......	......
100	St.	100	St.	100	Nim.	s w	8	s w	3	n e	2	42	30	2 p. m.	‡	......	......
100	St.	100	St.	100	St.	n e	4	n e	3	n e	4	35	29	....	10 a. m.	.43	.50
100	St.	100	St.	100	Nim.	n	3	n e	1	n w	2	36	30	8 p. m.	§	.04	......
100	St.	100	St.	100	St.	n	7	n w	10	n w	7	36	24	....	....	......	......
100	St.	30	Cir. Cu.	40	Cir.	n w	3	n	4	n	0	29	16	....	....	......	......
60	Cir.St.	70	Cu. St.	....	....	n e	2	n	6	n	3	30	9	....	....	......	......
....	....	70	Cir.St.	50	Cir.St.	s w	0	s w	8	s w	14	38	11	....	....	......	......
100	St.	100	St.	80	St.	s w	3	w	2	w	1	39	29	....	....	......	......
100	St.	10	Cir.	....	....	w	2	w	8	w	4	42	29	....	....	......	......
....	....	....	....	....	....	....	....	....	....	....	....	......	......	....	....	1.21	1.30
60.6	....	67.3	....	57.3	....	....	....	....	....	....	....	41.3	24.4	....	....	......	......
61.7						....	....	....	....	....	....	......	......	....	....	......	......

* In night. † Snow in night. ‡ Rain and snow. § During night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
S 1.....	38	55	51	48	100	87	93	.229	.376	.348	28.854	28.790	28.795	28.813
M 2.....	35	32	23	30	80	79	100	.170	.143	.123	29.016	29.099	29.146	29.087
T 3....	19	23	14	18⅔	100	100	100	.103	.123	.082	29.169	29.226	29.339	29.238
W 4.....	8	21	9	12⅓	100	100	100	.062	.113	.065	29.382	29.325	29.370	29.359
T 5.....	7	26	18	17	100	87	100	.060	.123	.098	29.414	29.344	29.349	29.369
F 6.....	15	32	24	23⅔	100	89	100	.086	.162	.129	29.376	29.286	29.289	29.324
S 7.....	29	32	33	31⅓	100	100	100	.160	.181	.188	29.155	29.175	29.226	29.185
S 8....	34	38	33	35	100	100	100	.196	.229	.188	29.066	28.917	28.913	28.965
M 9.. ..	32	32	31	31⅔	100	100	100	.181	.181	.174	29.044	28.928	28.886	28.953
T 10.....	31	32	31	31⅓	89	100	100	.155	.181	.174	28.897	29.061	29.211	29.056
W 11.....	31	34	21	28⅔	100	62	100	.174	.127	.113	29.274	29.328	29.421	29.341
T 12.....	24	36	38	32⅔	100	90	100	.129	.191	.229	29.365	29.141	29.073	29.193
F 13.....	44	49	32	41⅔	92	100	89	.265	.348	.175	28.783	28.659	28 755	28.732
S 14.....	21	17	7	15	100	100	100	.113	.094	.060	29.589	29.031	29.263	29.294
S 15.....	—1	7	1	2⅓	100	100	100	.042	.060	.046	29.376	29.374	29.357	29.369
M 16.....	—4	7	3	2	100	100	100	.036	.060	.050	29.294	29.159	29.113	29.189
T 17.....	0	12	14	8⅔	100	100	81	.044	.075	.067	29.024	28.969	29.027	29.007
W 18.....	3	7	0	3⅓	100	100	100	.050	.060	.044	29.006	29.085	29.237	29.109
T 19.....	—6	15	0	3	100	100	100	.033	.086	.044	29.290	29.325	29.402	29.339
F 20.....	4	14	3	7	100	100	100	.052	.082	.050	29.384	29.333	29.382	29.366
S. 21.....	—9	8	10	3	100	100	78	.029	.062	.054	29.384	29.299	29.139	29.274
S 22.....	16	30	28	24⅔	100	89	100	.090	.148	.153	28.798	28.586	28.604	28.663
M 23.....	30	35	32	32⅓	100	100	100	.167	.204	.181	28.644	28.628	28.732	28.668
T 24.....	30	35	32	32⅓	89	80	100	.155	.162	.181	28.894	28.830	28.830	28.851
W 25.....	31	34	32	32⅓	100	100	100	.174	.196	.181	28.974	29.133	29.198	29.102
T 26.....	32	35	34	33⅔	89	100	89	.162	.204	.175	29.124	28.980	29.023	29.042
F 27.....	30	35	29	31⅓	100	80	100	.167	.162	.160	29.185	29.221	29 266	29.224
S 28.....	29	32	37	32⅔	88	100	100	.142	.181	221	29.055	28.938	28.918	28.970
S 29.....	28	32	29	29⅔	100	100	100	.153	.181	.160	28.739	28.763	28.908	28.803
M 30....	14	34	30	26	100	89	100	.082	.175	.167	29.000	28.884	28.977	28.954
T 31.....	29	30	18	25⅔	88	100	100	.142	.167	.098	29.013	29.205	29.333	29.184
Sums.....	......	......	......	......	......	.....	......	......	......	......	....	....	....	....
Means....	......	......	......	......	97.25	94.58	97.74	.1226	.156	.1347	....	....	....	29.099
Average..	......	......	......	......	96.52			.1378			....	....	....	....

DECEMBER, 1901, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermometer.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
				60	St.	s w	8	s w	11	s w	5	57	34	*	*	.19	
100	St.	20	Cir.			n w	5	n w		n e		36	18				
20	Cir.St.	100	St.			e		n e		n e		25	6	†	‡	.02	.20
		10	Cir.			n		n		n e		22	4				
		40	Cir.St.			s e		s		s		27	7				
20	Cir.					s		s		s		34	15				
100	St.	100	Nim.	100	St.	s w		s w		s w		34	28	9 a. m.			
100	Nim.	100	Nim.	100	Nim.	s e		s e		e		40	31		*	.81	
100	Nim.	100		100	Nim.	n e		n e		n		34	25				
100	Nim.	100		100	Nim.							33	30	Snow.	Snow.		
100		100											19				
100		100		100								45	23	*			
100		100		100		s		s		n w		50	21	9 p. m.	9 p. m.	1.42	
100						w		w		w		22	—2		‖		
		40	Cir.St.			w		w		w		11	—5				
						w		w		w		11	—4	‖	‖	Trace	
70				100		s		s		s w		14	0				
80						s w		s w		s w		15	—6				
						s w		s w		s w		16	—5				
100		100		100		s w		s w		s w		17	—10				
		40				s w		s		s		16	—9				
60		30				s		s		s		30	16				
90		90		90		s		s		s		36	29				
100		90		100		s		s		s e		36	29	3 p. m.			
100		80		70		n w		w		s w		35	28		*	.375	3.75
90		90		90		s w		s w		s w		36	29				
100		80		80		n w		n w		s		35	24				
90		80		70		s		w		s w		34	24				
90		90		70		w		e		s e		32	12				
20		20		80		w		w		w		34	13				
						w		w		w		31	2				
																2.815	3.95
55.0																	

* In night. † Snow, 9 a. m. ‡ Snow, 4 p. m. ‖ Snow in night.

BULLETINS

OF THE

AGRICULTURAL COLLEGE EXPERIMENT STATION

ISSUED DURING THE

YEAR ENDING JUNE 30. 1902

EXPERIMENT STATION BULLETINS.

SOME EXPERIMENTS WITH BEET PULP AS A STOCK FOOD.

C. D. SMITH, DIRECTOR.

Bulletin No. 193.

INTRODUCTION.

The figures published in this bulletin as expressing the value of beet pulp must be understood as based upon single continuous experiments only, and should not be relied upon implicitly by the practical feeder as showing what he may expect from pulp in his operations, until they are confirmed or modified by future experiments.

The establishment of beet sugar factories in Michigan has furnished farmers a new stock food in the shape of beet pulp. This pulp is clean in appearance, almost odorless, very wet and heavy, but readily eaten by all kinds of live stock. As the pulp leaves the factory, it passes through a press which removes some of the water, but leaves from 89 to 93 pounds of water to each hundred pounds of pulp. In Germany presses have been introduced which reduce the per cent of water to 80. Where each hundred pounds of pulp is made up of 90 pounds of water and 10 pounds of dry matter it is evident that a ton of it will have but 200 pounds of dry matter. If by the use of improved presses a pulp can be produced by the factories one hundred pounds of which shall contain but 80 pounds of water, with 20 pounds of dry matter, it is evident that a ton of it will contain 400 pounds of dry matter. In other words, regarding the water as of no value, a ton of the pressed pulp is worth, as far as content of dry matter is concerned, twice as much as a ton of the pulp as found in the piles of the material at the factories in Michigan. Experiments in this country and abroad have shown conclusively that while the addition of a succulent feed to a ration otherwise made up of dry feeds, produces results indicating a value to the succulent food out of all proportion to its content of dry matter, forcing an animal to consume an undue amount of water results in a positive loss.[*] It is, therefore, to be hoped that ere long the factories, upon finding a demand for the pulp as a stock food, will so prepare it as to leave in it no greater per cent of water than 80.

Many of the Michigan factories handle as high as 600 tons of beets per day, turning out fully 300 tons of pulp. The average campaign is not less than 90 days. It is safe to estimate the annual output of beet pulp in this State with the present 13 factories, as fully 300,000 tons. The economical utilization of this vast amount of material is therefore a question of considerable moment. At nearly all the factories the great bulk of the pulp is left to decay where it is dumped by the conveyor. Such a state of things imperils the health of nearby residents and makes the factory a nuisance which the owners must take means to abate. The farmers in the vicinity of the factory are interested in the question whether the pulp is a valuable stock feed, whether it will pay them to haul it to their barns, and, finally, how it should be fed to derive from it the greatest possible good.

It takes a long series of experiments to determine with any degree of certainty the value of any new feeding stuff. The results of a single experiment are apt to be misleading. The values set upon the new material may be much too high, or subsequent experiments may prove them too low. The Michigan Experiment Station proposes to conduct a series of experiments to test the value of beet pulp as a succulent food when combined with dry feeds. Two such experiments with steers were conducted during the winter of 1900-1901 and are reported in this bulletin.

---

[*] Armsby's Manual of Cattle Feeding, page 135; Maercker and Morgan, Wesen und Verwertung der Getrockneten Diffusionsruckstände der Zuckerfabriken, page 6.

Practical feeders will understand that the figures given below as to the value of pulp are not to be taken as a safe basis for calculations in their own feeding, but simply as the results from single experiments, which may be modified, corrected, or completely upset by future experiments. It is manifestly the duty of the Station to report the progress of its work, and hence this bulletin is issued to place upon record the data thus far obtained, expecting future experiments to eliminate the errors which they are almost certain to contain.

The first experiment was conducted through the kindness of Hon. A. W. Wright on his "Grafton Farm," near Alma. Mr. Wright was feeding several hundred steers on his farm, using pulp as the basis of the ration. Having abundant cheap pasture, he was not trying to fatten the steers rapidly during the winter, but to carry them through with as little outlay as possible. He generously donated the use of his barns and fifty steers for the test, furnishing also the feed and a large part of the care, allowing the Station to supervise the feeding and make the necessary weights. Because the steers were thin in flesh, and because neither the hay nor the corn stover was of the very best quality but was such as was at hand, it is possible that the values of the pulp expressed in weights of these particular feeds are too high when considered in reference to hay and corn stover of better quality.

Hon. A. M. Todd, of Pearl, in Western Michigan, was also feeding a large number of steers, and using beet pulp with part of them. He kindly allowed the Station to send a representative to supervise the feeding, and do the weighing. The steers in this case were fed to fatten as rapidly as possible.

It is difficult to fix upon a correct measure by which to estimate the real value of a succulent food. A succulent food cannot be compared justly with a dry food upon the basis of a chemical composition alone. The experience of Scotch and English farmers with turnips, and of the American farmers with rape, the former containing as high a per cent of water as the average pulp, and the latter within six per cent as much water as pulp, has shown the practical feeder that the succulence itself of these useful fodders is an element which must be taken into consideration. The addition of such a succulent fodder, even though mostly water, to a ration otherwise made up of dry forage and grain increases the efficiency of the entire ration to an amount by no means indicated by the feeding value of the succulent feed alone, or by the chemical composition of such succulent feed. In the experiments reported in this bulletin the method of studying the relative values of the pulp and the other factors of the ration is as follows: When the experiment was conducted with steers, there was fed to one lot a ration made up of hay, corn stover and grain. To another lot the same dry feeds were given, and beet pulp added. In one case the amounts of the dry feeds given to the two lots were equal, and the pulp was given as an extra. In this case the measure of the value of the pulp is expressed in terms of the greater gains made by the lot to which the pulp was given. In other cases, a less amount of each of the dry feeds was consumed by the lot of steers receiving pulp. In other words, the pulp was substituted for part of the dry feed. To determine the value of the pulp in terms of the other feeds, it was necessary to find how much of the several kinds of feed had to be fed to produce a hundred pounds of gain with each lot. In the experiments reported below it happened that it required less of the dry feeds to make a hundred pounds of gain with the lots receiving pulp. Knowing how much pulp the lot of steers ate per 100 pounds of gain, and how much less of the other feeds they required to produce a hundred pounds of gain, it was assumed that the pulp eaten took the place of the excess of dry feeds eaten by the pen having no pulp, and from these data the value of a ton of pulp was estimated.

Where the test was conducted with milch cows a similar plan was adopted. To one lot of cows pulp was given in addition to a dry ration which was fed alike to both lots. The efficiency of a ration for cows is the amount of milk and butter fat yielded by the cows. In the experiment reported below it is seen that the cows gave as much fat when no pulp was fed as when they had pulp, although there was an immaterial increase in the milk flow. The measure of the value of the pulp, had any been shown by the test, would have been derived from a comparison of the amounts of feed required to produce a hundred pounds of butter fat with and without pulp.

SUMMARY.

1. The experiments at this Station, combined with the experience of practical farmers, show that steers, milk cows and sheep are fond of beet pulp.

2. In an experiment on the farm of A. W. Wright, where steers were fed with the object of carrying them through the winter with as little outlay as possible, and where the ration was made up of mixed hay, shredded corn stover, and grain ration, consisting of corn and beet seed ground together, one lot of 30 steers had pulp while a second lot of 20 steers had the same ration of hay, stover and grain, but no pulp. It required per day and steer with the pulp-fed lot, 55 pounds of pulp, 8.5 pounds of mixed hay, 4 pounds of shredded corn stover, and 2.4 pounds of the ground grain. On this ration the steers made an average daily gain of 1.42 pounds. The lot receiving no pulp had for a daily ration 11.5 pounds of mixed hay, 8 pounds of shredded corn stover, and 2.4 pounds of grain, and made daily gain of .684 pounds. Comparing the amounts of food consumed by each pen to produce a hundred pounds of gain, and computing from this data the value of a ton of pulp as an *additional* succulent fodder, the tests show that under the conditions existing a ton of pulp, fed with the other factors of the ration, took the place of 421.5 pounds of corn stover, 274 pounds of mixed hay, and 68.8 pounds of grain. Practical feeders will naturally wait for the confirmation of these figures by future experiments before basing their operations upon them.

3. In the experiment on the farm of A. M. Todd, a herd of twenty steers of mixed breeding, and in poor condition was divided into two lots, to one of which was given a ration of mint hay, somewhat mouldy, but palatable, wheat bran or oats, and corn meal; while to the other lot was given the same ration, and beet pulp in addition. The latter lot made an average daily gain of 2.52 pounds. While the steers which had no pulp made a daily gain of 1.84 pounds. Making the computations as before to find the estimated value of a ton of pulp, we find that under the conditions existing at Pearl, a ton of pulp took the place of 244 pounds of mint hay, 32.6 pounds of wheat bran, 296 pounds of corn meal, and 27.2 pounds of oats. During the last week of this experiment the lot of steers having no pulp were off feed and made no gains. If, for this reason, the experiments were brought to a conclusion a week earlier the estimated value of the pulp would be reduced approximately by one-third. These figures result from a single experiment and must therefore await confirmation before being taken as the statement of the station in the matter.

4. Where, in the last experiment, two lots of ten steers each were fed the same kind and amount of dry feed for six weeks and to the ration of one lot pulp was added, the feeding of 13,775 pounds of pulp gave an increased gain of 280 pounds.

5. When fed to milk cows at the College, with mixed hay, and a grain ration of two parts bran to one of corn, the pulp added nothing to the yield of butter fat. It increased somewhat the milk flow.

6. Experiments with milk cows at the Cornell Experiment Station, in New York, reported in Bulletin 183, indicated that the dry matter of the beet pulp and of corn silage were of equal value. To furnish the same quantity of dry matter requires twice as much of ordinary pulp as of silage.

7. The consensus of opinion among farmers who have fed pulp is that for milk cows it is a good feed, although the pulp from frozen beets should be used with caution. Growing and fattening cattle do well on it, and owners declare that it saves one-third of the coarse fodder. Both fattening lambs and breeding ewes like pulp, and for them it proved a valuable factor in the ration.

FEEDING EXPERIMENT WITH STEERS ON THE GRAFTON FARM OF HON. A. W. WRIGHT, ALMA, MICH.

CONDUCTED BY LEO M. GEISMAR, SUPERINTENDENT OF UPPER PENINSULA EXPERIMENT STATION.

This farm is situated near the factory and the pulp for the feeding was hauled daily. Samples were taken for analysis from the bulk of pulp hauled in the early winter and later, toward spring after the factory had shut down and when the pulp had to be obtained from the pulp piles. Sample No. 1 was taken from the pulp as it came from the factory and sample No. 2 from the pulp pile. The results of the analyses appear in the following table which also includes a statement of the composition of ordinary sugar beets taken from Henry's "Feeds and Feeding."

Chemical composition of pulp and sugar beets.

	Water—per cent.	Protein—per cent.	Ash—per cent.	Crude fiber—per cent.	N. free extract—per cent.	Crude fat—per cent.
Sample 1	89.95	.927	.365	2.29	6.331	.137
Sample 2	91.40	.726	.298	1.706	5.795	.075
Sugar beet	86.5	1.8	.9	.9	9.8	.1

Next follows a table giving the composition of beet pulp, as reported under sample 1 above, compared with that of well known stock foods.

Chemical composition of cattle foods.

	Water—per cent.	Protein—per cent.	Crude fiber—per cent.	N. free extract—per cent.	Fat—per cent.
Beet pulp (fresh)	89.95	.927	2.29	6.33	.14
Beet pulp (ensiloed)	88.52	1.08	2.80	6.41	.11
Beet pulp (dried)	12.58	6.54	18.57	....	56.29
Corn silage	79.1	1.7	6.00	11.00	.8
Pasture grass	80.	3 5	4.00	9.7	.80
Turnips	90.5	1.1	1.2	6.2	.2
Timothy hay	15.00	6.00	29.6	41.9	3.0
Corn stover	40.5	3.8	19.7	31.5	1.1
Red clover hay	20.8	12.4	21.9	33.8	4.5

It is interesting, next, to study the composition of the dry matter of these feeding stuffs. A table setting forth these facts indicates pretty closely the relative values of the different foods with the water removed.

Composition of dry matter of pulp and other cattle foods.

	Protein—per cent.	Crude fiber—per cent.	N. free extract—per cent.	Fat—per cent.
Beet pulp	9.22	22.79	63.00	1.36
Corn silage	8.1	28.7	52.6	3.82
Pasture grass	17.5	20.	48.5	4.00
Turnips	11.71	12.6	65.2	3.00
Timothy hay	6.80	33.41	51.72	2.88
Corn stover	6 38	33.11	52.94	1.85
Red clover hay	14.52	29.12	44.98	3.89

The composition of ensiloed pulp and the dried pulp is taken from the monograph of Maercker on the "Value and Characteristics of Dried Beet Pulp" published in 1891.[*]

The similarity in the composition of the dry matter of pulp and corn silage is significant. There are indeed other factors to consider in determining the value of a stock food but the chemical composition indicates in a general way what may be expected of it. At the Cornell University[†] a trial was made with milk cows, feeding alternately beet pulp and corn silage. It was found that the pulp would replace the silage without loss of yields, giving of course twice as much pulp to secure the same amount of dry matter. The results of this test confirms the indications set forth in the table above.

No statement is at hand as to the digestibility of the pulp either fresh or dried, but considering the amount of protein in the pulp, it should compare favorably with the other rough feeds mentioned in the table.

Mr. Wright was feeding several hundred steers on his various farms. The steers set aside for this test were for the most part shorthorn grades averaging 754 pounds in weight on December 10 when the experiment began. The herd was divided into two lots, one containing thirty steers to receive pulp and the other twenty steers to be fed the same basal ration but no pulp. This basal ration consisted of hay, a mixture of clover and timothy, not of the best quality and a grain ration made up of corn and beet seed ground together. This mixture was fed alike to all the steers in the test and was not analyzed.

The steers ran in covered yards, with water at hand, and were well protected from the cold. Prior to the beginning of the experiment all of the steers had received pulp. It was necessary, therefore, to gradually remove the pulp from the twenty steers, that, during the experiment, were to receive none. This was done during the week beginning December 4.

The following tables give the details of the work as far as needed to understand the results:

Weights of steers and gains.

Lot I, with pulp, 30 steers.			Lot II, without pulp, 20 steers.		
	Weights—pounds.	Gain—pounds.		Weights—pounds.	Gain—pounds.
December 10	22,800		December 10	14,805	
December 24	23,100	300	December 24	14,725	*
January 7	23,865	765	January 7	14,930	205
January 21	24,610	745	January 21	15,250	320
February 4	25,030	420	February 4	15,310	60
February 18	25,570	540	February 18	15,610	300
March 4	26,420	850	March 4	15,930	320
March 11	26,680	260	March 11	16,050	120
Total		3,880	Total		1,245
Gain per steer, 129.33 pounds. Gain per steer per day, 1.42 pounds.			Gain per steer, 62 25 pounds. Gain per steer per day, .684 pounds.		

* Loss 80 pounds.

The gains were not large with either lot. The steers were not fed large amounts of grain at any time during the test because it was not Mr. Wright's plan to make gains but to carry the steers through the winter as economically as possible. While the difference in total gain is therefore significant, it does not indicate wholly the value of the pulp. The thirty steers receiving pulp did not shrink during the trying month of December, as did the twenty steers not receiving pulp.

---

[*] "Wesen und Verwertung der getrockneten Diffusionsrückstände der Zuckerfabriken," page 15.

[†] Bulletin 183.

FEED CONSUMED.

To economize space, the records of the feed consumed is given below in tables which hardly need explanation. The steers were weighed each two weeks, and the amount of feed consumed in these intervals is given in the tables.

The steers were allowed all the rough forage they would eat clean. The amount of the grain feed, corn and sugar beet seed ground together, was so regulated as to allow daily the same quantity to every steer in each lot. Naturally the steers receiving pulp ate less hay and corn stover per animal than did the lot receiving none of the succulent fodder.

Feed consumed in periods of two weeks.

Lot I, 30 steers.						Lot II, 20 steers.				
	Gains—lbs.	Hay—lbs.	Shredded stover—lbs.	Pulp—lbs.	Grain—lbs.		Gains—lbs.	Hay—lbs.	Shredded stover—lbs.	Grain—lbs.
December 24	300	5,490	....	12,635	450	December 24	loss 80	4,440	....	330
January 7 ...	765	5,155	....	17,080	750	January 7 ...	205	4,955	....	530
January 21 ..	745	4,530	....	19,390	885	January 21 ..	320	4,300	....	590
February 4..	420	3,630	1,080	22,245	855	February 4..	60	3,300	1,600	570
February 18.	540	1,905	3,600	25,320	1,230	February 18.	300	1,680	4,800	820
March 4	850	1,675	3,600	30,655	1,500	March 4	320	1,420	4,800	1,000
March 11	260	885	2,400	23,420	960	March 11	120	920	3,200	640
Total	3,880	23,270	10,680	150,745	6,720	Totals	1,245	21,015	14,400	4,480
Feed per steer.......	....	775.7	356	5,024.8	224	Feed per steer.......	....	1,050.7	720	224
Feed per 100 lbs. gain...	....	600	275.3	3,885	173.2	Feed per 100 lbs. gain...	....	1,686.7	1,156.6	359.8

Comparison of results.—Feed per 100 pounds gain.

	Pulp—pounds.	Stover—pounds.	Hay—pounds.	Grain—pounds.
Lot II..	....	1,156.6	1,686.7	359.8
Lot I..	3,885	275.3	600	173.2
	....	881.3	1,086.7	186.6

A comparison of the amount of feed required to produce a hundred pounds of gain indicates that 3,885 pounds of pulp was equal in feeding value to 881.3 pounds of stover, 1,086.7 pounds of hay, and 186.6 pounds of grain. This statement is not fully justified by the experiment, however, since the effect of the removal of the pulp was not complete with Lot II until December 24, if it was then. With this lot there was a continual shrinkage until that time. It is impossible to estimate the allowance that should be made for this factor. Considering the test to begin January 7, when surely the influence of the change from succulent to dry feed would have largely spent itself, we have the gains with the pulp fed steers up to March 11, 2,815 pounds, or 93.8 pounds per steer, while without pulp the twenty steers gained 1,120 pounds, or 56 pounds per steer. The comparison of the feed per hundred pounds of gain would then be as follows:

Feed per 100 lbs. gain.—Jan. 7 to Mar. 11.

	Pulp—pounds.	Stover—pounds.	Hay—pounds.	Grain—pounds.
Lot II	....	1,285.7	1,037.5	323.2
Lot I	4,299.4	379.4	448.4	175.1
	....	906.3	589.1	148.1

The value of a ton of pulp in each case, expressed in terms of the other feeding stuffs, would be as follows:

Value of one ton of pulp.

	Stover—pounds.	Hay. pounds.	Grain—pounds.
From December 10	453.7	513.1	96
From January 7	421.5	274	68.8

These tables take into consideration the value of the pulp as shown by the increased gains of the steers receiving pulp over those which had none. Again it must be remembered that it was the intention to furnish a ration but little better than a maintenance ration. The gains were to be regarded as incidental. To carry a steer through thirteen weeks of winter, without attempting to make the gains made in the interval pay for the feeds, but to keep the animal thrifty and growing, it required per steer, 5,024.8 pounds of pulp, with 775.7 pounds of mixed hay, 356 pounds of shredded stover, and 224 pounds of grain. Without the pulp it required, per animal, 275 pounds more hay, and 364 pounds more stover. Taking these figures as a basis and remembering that each steer fed pulp gained 67 pounds more in weight in the 13 weeks, it is possible to estimate the value of the pulp as a factor in a ration designed to carry steers through the winter cheaply, if that form of cattle feeding is ever desired.

The values indicated for the pulp will strike the reader as unduly high. Let it be remembered that they are derived from a single experiment and are not reported here as final but are subject to such correction as future experiments may show to be necessary.

FEEDING EXPERIMENT WITH STEERS ON THE FARM OF HON. A. M. TODD, PEARL, MICH.

CONDUCTED BY WALTER C. BOURNS.

The steers had been picked up in the surrounding country and were of all sizes and ages, and represented many breeds and combinations of breeds, making the sorting into lots of equal feeding capacity a difficult problem.

The barns consisted of one large, central hexagon, of fifty-foot sides, from which, on the six sides, project wings fifty by sixty-six feet. In one of these wings the test was carried forward, the steers fastened in two rows, facing each other, with a four-foot alley between them. The steers were fastened by a chain tie sliding on a vertical bar. They were bedded with mint straw. Water was given in pails in the manger, once per day. While no weights of the water were made, it was not noted that the steers consuming pulp took less water than the other lot.

The pulp had been brought to the railroad station at Pearl from Holland on cars and was thence hauled to the silos with teams. It had been put in the silos in December. The pulp did not ferment to any appreciable extent but was bright and fairly white in appearance. The steers had, for rough feed, mint hay, of fairly good quality though somewhat mouldy at times. The grain feed consisted of corn meal mixed with bran at the beginning of the test and later with oats.

Up to February 18 the steers were weighed at 2:30 in the afternoon, after receiving their mid-day ration and after watering. Thereafter they were weighed in the morning before feeding. On the 18th of February they were weighed twice, once in the early morning and again in the afternoon. In estimating the gain the latter weight is used to compare with the weights on the days preceding, while the morning weight is used to determine the gains after February 18. The steers were weighed at intervals of two weeks. The following table gives the weights on the dates named:

Weight of steers at intervals of two weeks and gains.

Lot I, with pulp (10 steers.)			Lot II, without pulp (10 steers.)		
	Weights—pounds.	Gains—pounds.		Weights—pounds.	Gains—pounds.
January 21	9,559	....	January 21	9,511	....
February 4	10,030	471	February 4	9,800	289
February, A. M., 18	9,786	....	February, A. M., 18	9,800	....
February, P. M., 18	10,344	314	February, P. M., 18	10,095	295
March 4	10,224	438	March 4	10,159	359
March 18	10,420	196	March 18	10,376	217
March 25	10,592	172	March 25	10,376	....
Total	....	1,591	Total	....	1,160
Gain per steer per day, 2.52 pounds.			Gain per steer per day, 1.84 pounds.		

FEED CONSUMED.

From the beginning of the experiment to the fourth of March both lots of steers were fed the same amount of hay and grain, and to lot 1 the pulp was given extra, in addition to the regular ration. After the fourth of March the lot receiving pulp was fed less of the dry ration to make some allowance for the dry matter in the pulp. The next table gives the weight of the feed consumed.

Feed eaten during intervals of two weeks.

	Lot I, with pulp.					Lot II, without pulp.			
To—	Hay—pounds.	Pulp—pounds.	Bran—pounds.	Corn meal—pounds.	Oats—pounds.	Hay—pounds.	Bran—pounds.	Corn meal—pounds.	Oats—pounds.
February 4	1,375	4,150	140	1,430	....	1,375	140	1,430	....
February 18	1,610	4,825	240	1,960	....	1,610	240	1,960	....
March 4	1,485	4,800	240	1,960	....	1,485	240	1,960	....
March 18	1,260	5,175	126	1,432	562	1,400	140	1,595	625
March 25	630	2,700	108	882	....	700	120	980	....
Totals	6,360	21,650	854	7,664	562	6,570	880	7,925	625

Considering first the feeding period as a whole, and computing the amounts of the several feeding stuffs required to produce a hundred pounds of gain with each lot of steers we have the following table:

Feeds required to produce 100 lbs. of gain.

	Pulp—pounds.	Hay—pounds.	Bran—pounds.	Corn meal—pounds.	Oats—pounds.
Lot I	1,361	400	53.6	481.7	35.3
Lot II	....	566	75.8	683.1	53.8
Difference	....	166	22.2	201.4	18.5

In lot 1 the steers ate 1,361 pounds of pulp for each hundred pounds added to their weight. It required, however, 166 pounds less hay; 22.2 pounds less bran, 201.4 pounds less corn meal and 18.5 pounds less oats for a hundred pounds of gain than were required of these materials for an equal gain with the steers having no pulp. Without going into the question as to whether there was a profit in the feeding, a matter which depends on the relation between the prices of beef and the feeding stuffs mentioned, it is taught by the test that a ton of pulp at the rate just computed is worth 244 pounds of hay, 32.6 pounds of wheat bran, 296 pounds of corn meal and 27.2 pounds of oats so far as efficiency in producing gains is concerned.

After March 18 the weather turned warm and the steers without succulent feed stopped gaining. If for this reason we conclude the experiment on March 18, we find the gains of lot 2 to be 1,160 pounds as before, while the gains of lot 1 are 1,419 pounds only. Up to that date lot 1 had eaten 18,950 pounds of pulp, but had also not required as much hay and grain, the difference being 140 pounds of hay, 14 pounds of bran, 163 pounds of corn meal, 63 pounds of oats. Estimating as before, the feeds required to produce a hundred pounds of gain and computing from the data thus given the estimated value of a ton of pulp in terms of the other foods we find one ton of pulp to produce as much gain as 153.6 pounds of mint hay, 19.7 pounds of bran, 181.2 pounds of corn meal, and 21.4 pounds of oats. These figures are less than when the whole period is considered because the lot having no pulp gained in this case up to the close of the period, while if we carry the experiment to March 25 the lot without succulent food made no gains during the last week, although they kept on eating. The former figures, however, are just, because the better appetite of the lot receiving pulp is clearly due to the succulent feed.

Up to March 4 both lots received the same quantity of hay and grain, the pulp being fed extra. The difference in gains for the six weeks was 280 pounds, the pulp consumed meanwhile being six tons, 1,775 pounds.

FEEDING EXPERIMENT WITH DAIRY COWS.

This experiment was conducted during the winter of 1898-1899. Eight cows, selected from the grade dairy herd, were set aside for the test. The history of the cows for the year preceding had been carefully kept as to yields of milk and butter fat and it was therefore easy to find two groups of four cows each, well matched as to milk giving capacity and relation to date of birth of last calf.

The experiment began on December 28, 1898, the first week on the various feeds being considered a preliminary period only, with results not included in the weights used in making up the final results.

The cows had been fed corn stover, hay, and a grain feed composed of bran and corn meal, up to the time of the beginning of the experiment. Nearly all the cows had calved within the five weeks preceding that date and all of them after the middle of October,

1898. They were all grade shorthorns although No. 86 showed that there was some Jersey blood in her ancestry. Neither the age nor the breeding of the cows can be given as they had been purchased a year previous in various parts of the State.

The plan of the experiment was to feed one lot of cows pulp for six weeks then follow with six weeks in which the same ration of hay and grain should be given, but without pulp. Another lot was to be fed the dry feed for six weeks, then have the pulp for the following six weeks.

The cows were kept in Bidwell stalls nights and stormy days but let out to water and exercise except when the weather was unpleasant. The feed was weighed to each animal daily. The milk as weighed as milked and tested from a composite sample weekly, each cow's milk being treated separately.

The next table gives the dates of the birth of the last calf preceding the beginning of the experiment, and where possible the yields of milk and fat for the previous period of lactation. The cows in this herd are designated by number, not by name.

List of cows with dates of birth of last calf and yields in last period of lactation.

Cow No.	Last calf born—	Preceding period of lactation.	
		Milk—pounds.	Fat—pounds.
92	November 23, 1898	6,009.8	234.58
138	December 7, 1898		
86	November 11, 1898	5,687.7	244.36
97	October 26, 1898	6,745.7	249.27
105	November 9, 1898	6,931.6	269.10
109	October 23, 1898	5,820.3	216.05
98	November 28, 1898	8.135 3	327.69
106	December 8, 1898	8,208.9	305.21

The experiment began December 28. Preliminary feeding period to January 4. The first feeding period from January 4 to February 8. Intervening week February 8 to February 15. Second feeding period from February 15 to March 22 inclusive.

The following table gives the numbers of the cows selected for each group and their weights at the beginning of the test, December 28, February 8 and March 22:

Weights of cows.

Group I.				Group II.			
Number.	Pulp, first period.			Number.	Pulp, second period.		
	Dec. 28—pounds.	Feb. 8—pounds.	Mar. 22—pounds.		Dec. 28—pounds.	Feb. 8—pounds.	Mar. 22—pounds.
92	1,120	1,147	1,120	105	1,236	1,132	1,215
138	1,269	1,359	1,379	109	853	870	906
86	803	833	828	98	1,010	981	965
97	915	975	970	106	958	993	1,020
Totals	4,107	4,314	4,297	Totals	4,057	3,976	4,106

These records show that Group I gained, when eating pulp, 207 pounds and lost in the second period after the pulp was withheld, 17 pounds. Group II also gained in weight when eating pulp during the second period of the test, the gain being 130 pounds and lost in the first period when no pulp was given 81 pounds. The gross advantage in weight therefore due to the pulp was 435 pounds.

In the next tables are given the amounts of the different kinds of feed consumed by the several cows. Group I had pulp for the five weeks, from January 4 to February 8, and no pulp from February 15 to March 22. On the other hand, Group II had pulp the second period, and no pulp the first. If the feed consumed by Group I in period one be added to the feed eaten by Group II in period two the sum will be the amounts of the several feeding stuffs eaten by the cows when receiving pulp, and may be compared with the amounts similarly obtained by adding together the amounts consumed by Group I in period two and Group II in period one, which are the amounts of the several feeding stuffs eaten when no pulp was given.

The pulp was hauled, at the beginning of the experiment, from Bay City on cars to Lansing and thence to the dairy barn on wagons. It was stored in open bins until used. It neither froze nor fermented but kept fresh and sweet until eaten.

The cows ate the pulp greedily except cow 86 which could not be induced to eat a full ration of it.

The hay was mixed clover and timothy, one-fifth clover. It was well cured, bright and dustless.

Feeds consumed, and yields of milk and fat.

GROUP I.

Period I, with pulp.							Period II, without pulp.					
Cow No.	Pulp—lbs.	Hay—lbs.	Bran—lbs.	Corn—lbs.	Milk—lbs.	Fat—lbs.	Cow No.	Hay—lbs.	Bran—lbs.	Corn—lbs.	Milk—lbs.	Fat—lbs.
92	1,400	423	283	142	1,221.5	40.53	92	430	286	144	1,045.5	39.31
138	1,370	435	290	145	728.1	22.83	138	536	357	179	697.9	23.28
86	613	402	269	133	872.0	33.29	86	445	296	148	819.3	36.06
97	1,240	415	278	137	911.4	31.77	97	458	305	153	824.1	31.62
Totals.	4,623	1,675	1,120	557	3,733.0	128 42	Totals	1,869	1,244	624	3,386.8	130.27

GROUP II.

Period II, with pulp.							Period I, without pulp.					
98	1,210	366	244	122	801.6	29.96	98	399	266	133	781.1	30.14
106	1,210	374	250	124	891.1	31.10	106	393	262	131	840.0	29.29
105	1,210	559	373	186	945.5	36.62	105	568	379	189	1,003.0	38.32
109	1,210	407	272	135	887.4	33.57	109	420	280	140	832.7	30.35
Totals.	4,840	1,706	1,139	567	3,525.6	131.25	Totals	1,780	1,187	593	3,456.8	128.00
Totals.	9,463	3,381	2,259	1,124	7,258.6	259.67	Totals	3,649	2,431	1,217	6,843.6	258.27
Subtracting								3,381	2,259	1,124		
Leaves to offset 9,463 pounds pulp								268	172	93		

While the two lots were receiving pulp they ate 9,463 pounds of pulp, 3.381 pounds of hay, 2,259 pounds of bran, and 1,124 pounds of corn meal. In an equal period of five weeks, when the pulp was withheld, they ate 3,649 pounds of hay, 2,431 pounds of bran, 1,217 pounds of corn meal. Naturally without pulp they ate more of the dry feed than when they had it but, largely perhaps because the cows did not like the hay, they would not eat a full ration. Subtracting the hay and grain eaten with the pulp from the amount consumed when no pulp was given there remains 268 pounds of hay, 172 pounds of bran, and 93 pounds of corn meal to offset the 9,463 pounds of pulp, giving a value of 64.2 pounds hay, 40.6 pounds of wheat bran, and 22 pounds of corn meal to the ton of pulp. The pulp seemed to add nothing to the yield of butter fat.

Group I gave, in period one, with pulp, 128.42 pounds of butter fat, while in period two, without pulp, the yield was 130.27. Group II, on the other hand, gave 131.25 pounds of butter fat during the second period, with pulp, and but 128.00 pounds during the first period and without pulp. Both groups gave more butter fat in the second period than in the first, but when the amounts given with pulp are compared with the yields without pulp we find a difference of but one pound and four-tenths, 259.67 pounds of butter fat with pulp and 258.27 without it.

The milk yields tell a rather different story. The two groups when receiving pulp yielded 7,258.6 pounds of milk, while, when the pulp was withheld, the yield for the ten weeks was but 6,843.6 pounds, a difference of 415 pounds.

EXPERIENCE OF FARMERS IN FEEDING PULP.

There are given below several letters from farmers who have had experience in feeding pulp to cattle or sheep. They are published here to show, in a general way what the farmers who have fed pulp think of its value. The statements made in the letters are not claimed to be based upon careful experiment and the station does not vouch for their accuracy. The letters as a whole do express the opinions of practical feeders.

Bay City, Mich., July 31, 1901.

Director Michigan Experiment Station:

Dear Sir—I have fed beet pulp to dairy cows for two winters. During the last campaign of the factory I fed pulp to an average of 55 cows, registered Jerseys, the milk of the herd being sold to regular customers in Bay City. The pulp was hauled fresh from the factory each day, or at short intervals, and fed unfermented. The cows without exception ate the pulp readily from the start.

I used the pulp as substitute for corn ensilage. The cows had been receiving two feedings per day of corn silage, with hay and grain. After beginning with the pulp the hay and grain remained practically the same, and one feed per day of pulp was substituted for one feed of the silage. Unfortunately, at the time the changes in the feeding were made I was building a new barn, and the frequent changes in the stalls of the cows made it impossible to continue our regular records of the yields of each individual cow. I cannot, therefore, give a definite statement as to the influence of the feeding of pulp on the quality of the milk or its quantity farther than to say that no shrinkage in the yield of the herd as a whole seemed to follow the change from silage to pulp nor was there an apparent increase when the change was made back again to silage.

In the winter of 1899-1900 I also fed considerable quantities of beet pulp. While there was no bad effect from the feeding of pulp from unfrozen beets, I noticed a tendency to bloating and to bowel disorders as soon as I attempted to feed stored pulp from frozen beets.

Yours respectfully,
T. F. MARSTON,
President State Board of Agriculture.

Alma, Mich., August, 1901.

Director C. D. Smith:

Dear Sir—Through last winter I fed five cows and twenty-five sheep with beet pulp.

I fed the twenty-five sheep four bundles of fodder daily, and no grain until grass started, when I gave them a panful of corn each day. In addition, the sheep ate two bushels per day of the pulp. The sheep did splendidly all winter, were strong and healthy, but I do not think the lambs are quite as good.

To the cows, I gave cornstalks, mixed hay, timothy and clover, and the usual quantity of grain. They had daily about a bushel and a half each of beet pulp. This pulp they ate readily. It kept the coats sleek, and the cows kept up their flow of milk far better than they would have done without it. I am sure that the pulp saved me one-half of the coarse fodder.

Yours respectfully,
BYRON NEVINS.

Alma, Mich., 1901.

Director C. D. Smith, Agricultural College, Michigan:

Dear Sir—I have fed beet pulp two winters. In the first campaign I fed it to 22 head of cattle, some of them dairy cows. These cows, most of them, came in milk in late January. We kept somewhat careful account of our butter sales, and I am justified in reporting that our cows did as well through the months of February and March as they did when on grass in June. With the pulp I fed cornstalks, and corn, but no hay. We fed about as much of the rough fodder as we would have fed without pulp, and added the latter to the regular ration.

I had fourteen yearlings, to which I gave pulp three times daily without grain, but using cornstalks as a roughage. In March I added some corn for the grain ration. This young stock did splendidly through the winter, and were turned off in June.

Late in the spring I fed some pulp that was sour, but noticed that when the water was well drained from it the cattle liked it, and it did not act badly upon their bowels.

Again, in the second winter, I fed our milk cows cornstalks and pulp, with the very best of results. Again the cows did as well in the winter as they did in the summer. I fed four calves three bushels of pulp daily, and three bundles of cornstalks with no grain and no hay. These calves were a year old in April, except one, which was a year old in February. They grew right along so well that I sold the two steer calves in April for forty dollars. They were all very sleek and fat. I believe that beet pulp saves one-third of the coarse fodder, and keeps the stock in good growing condition or maintains the milk flow from the cows.

Yours respectfully,
FRED CHURCH.

Kalamazoo, Sept. 16, 1901.

Mr. C. D. Smith, Agricultural College, Michigan:

Dear Sir—The first year our sugar beet factory operated, I commenced to feed pulp as soon as I could get it, following it up the whole winter or as late in the spring as the pulp continued to be good, using from the waste pile we accumulated at the factory, cutting through the cap and frozen pulp which acted as a silo. We had most excellent results, finding it equal to cut green corn and roots. Of course we fed simultaneously bran and other milk making foods, with hay. We saved our ensilage that year until the pulp got bad and to feed during the dry spell which we usually have in August. The experiment was eminently satisfactory and I consider the pulp equal in every way to the very best ensilage. Last winter, we fed again in the same manner, as soon as the factory was in operation and did not store any away, expecting to continue feeding out of the waste pile as we did the year before, but discovered that the spent lime had been run into the waste pile and we were afraid to use the pulp and it was a very great disappointment to us, so much so, that I have taken such steps as will keep the spent lime from being run into the pulp this year.

My recollection is that we commenced to feed one-half a bushel of pulp a day and increased it gradually until my cows were eating one bushel a day, but at that point they seemed to get tired of it and the effect on their bowels was bad, and we dropped back to about a half a bushel a day and there we remained all winter. We fed the usual amount of grain ration, about eight pounds of bran and gluten meal, but got an increased flow of milk over our previous winter when we were feeding the same grain ration and ensilage.

I thought from the results the beet pulp assisted to assimilate the food to an unusual degree. My cows are Jerseys.

Yours very truly,
D. D. STREETER.

Bay City, Mich., August 2, 1901.

C. D. Smith, Esq., Agricultural College, Michigan:

Dear Sir—We used pulp as feed during the winter of 1900 and 1901, and consider it good feed for young cattle, milch cows and sheep, and expect to winter one hundred head of cattle on pulp this coming winter.

The only disadvantage we find in using it in cold weather is in its freezing which makes it difficult to feed, but we are now building a large silo which will hold several car loads of pulp and think we can keep it without freezing.

Have seen young cattle wintered on pulp and straw that came out in good condition, and think when farmers learn the benefits derived from its use they will not do without it as there is no doubt about its feeding qualities.

Yours truly,
P. C. SMITH.

Woodmere, Mich., Sept. 14, 1901.

Mr. C. D. Smith:

Dear Sir—In regard to the feeding quality of beet pulp, I can say that my cows were very healthy and relished it very much. They produced a large quantity of milk. I find that I have saved a good percentage of hay, feeding as high as two and a half bushels per day of pulp to each cow. I recommend it as a good milk producer.

Yours respectfully,
HENRY HOTCHKISS.

South Bend, Ind., Sept. 12, 1901.

Mr. C. D. Smith:

Dear Sir—My experience in feeding pulp is limited, as I had not a satisfactory equipment for preserving it. I have fed it in different ways, but have made no official test. I believe it to be a good feed. I could notice an increase in the milk on feeding pulp, and a decrease on its removal. I have fed it from November until March, but to milk cows only. It seems to be especially valuable for those who have not a silo, filled with corn silage, as I have, as it is a succulent food, a good tonic, and beneficial if properly cared for.

My method is as follows: Receive the pulp fresh from the factory, silo it where the liquid in it can be held, salt it lightly, silo it with ground corn, oats, bran, gluten or any by-product which the feeder may have by placing a layer of each alternately. I have fed the material thus siloed in December late in March as fresh and good as at first.

Yours truly,
J. A. JACKSON, R. R. No. 3.

St. Louis, Mich., August 12, 1901.

Prof. C. D. Smiith, Michigan Agricultural College:

Dear Sir—Yours of the third received. I fed six steers last winter on beet pulp and cornstalks exclusively. I sold these steers the fore part of the winter to be delivered April 1, and intended to feed meal with pulp the last two months, but they were doing so well I thought I would carry the experiment to a finish without feeding grain. We were unable to get pulp after the middle of February, and not having enough on hand to feed until the first of April, I told the buyer I would deliver them any time. He came to look at them the next day and was so well pleased with their condition that he took them at once. They were shipped March 6.

I have fed pulp three winters, and am well pleased with it, and am sure that I can winter in better shape on the same amount of coarse feed ten head with pulp than five head without.

Yours respectfully,
I. D. SUYDAN.

Vicksburg, Mich., August 29, 1901.

Mr. C. D. Smith:

Dear Sir—In reply to yours of the 12th I would say that I have fed beet pulp for two winters, and like it very much. A year ago last winter I fed it to fifty-six head of steers, commencing about the first of December. I mixed meal with it. I weighed a few of the steers the 30th of each month. They made an average gain of seventy pounds a month until the pulp was all gone, which was the last of February. The next month we increased the meal a quarter, and they only gained 49 pounds on the average.

Last winter I fed it all winter, and up to May. I fed 20 cows and 10 steers, feeding all the pulp they would eat, with meal. My steers did well, but I did not weigh them to see how much they gained. I did not grain very heavy, one basket of broken corn going to 10 head twice a day. I believe the pulp to be splendid for cows, as it keeps them in a thriving condition. When I started to feed it in November I was milking twelve cows and the third day they had gained 76 pounds in their milk. I fed nearly or quite 250 tons last winter, and never had my cattle do as well.

Yours truly,
W. R. SOUTHWORTH.

Alma, Mich., August 6, 1901.

Mr. C. D. Smith:

Dear Sir—Yours at hand. In regard to pulp I feed from one to two bushels to a cow at a feed, with no grain. I get a good flow of milk. I think it is all right. In commencing to feed it it is sometimes necessary to mix it with bran, as some cows do not take to it readily.

Yours respectfully,
P. N. GRANGER.

Director C. D. Smith:

Dear Sir—To forty-five steers which I was carrying through the winter last winter I fed three cubic yards daily of beet pulp. The steers were fed during December, January and February. They were fed fodder corn, stalks and all, that would go about thirty-five bushels of ears to the acre. While no weights were taken, the steers showed by their general appearance that they were growing rapidly and doing finely. I noted in the spring, however, that when the pulp was removed the steers did not look as well as they had been doing, nor did they do as well on the grass as if confined to dry fodder during the winter.

Our cows certainly gave at least three to five quarts of milk daily more when fed pulp than they did when we could not get it. Moreover, they did not consume anywhere nearly as much other coarse fodder.

To one hundred ewes I gave nothing but pulp through November and December, while the ewes were running on a meadow. After the holidays I fed drilled corn, but I am sure they did as well on the pulp alone as they did on the corn. I have a hundred and thirty lambs from the hundred ewes. The lambs are strong and vigorous, and are growing finely.

Yours truly,
THOMAS FITZGERALD.

EXPERIMENTS ELSEWHERE.

In the Breeders' Gazette, Chicago, Ills., issue of June 19, 1901, there is given a report of an experiment carried on by R. M. Allen, of the Standard Cattle Company, Ames, Neb., with beet pulp as a food for fattening sheep. The experiment was on so large a scale and was carried on with so much care that the essential facts are here given to show what has been done with pulp by the practical feeder in Nebraska. The report is taken from the journal mentioned, pages 1139 and 1140.

Mr. Allen writes: "The past winter, we fed on pulp 30,000 sheep, which were fed regularly from the beginning to the end. This is the only thorough experiment we have made in pulp feeding, and I send you herewith some figures showing actual results. These are figures of averages and include all classes of sheep. The heaviest wethers sold averaged 135 pounds, the heaviest lambs 100 pounds, at market. Some of the sheep sold on the Omaha market killed out 52 per cent of dressed mutton, and I am inclined to think that the percentage improved after that. Some individual sheep killed at Ames dressed upwards of 56.8 per cent.

"We have not, even to the largest sheep, fed to exceed eleven pounds of pulp per head a day at any time, and our maximum average feed was ten pounds a day. We are inclined to think that this is too large a feed of pulp to grown sheep, and that seven or eight pounds is rather more than should be fed to lambs. At first the effect of a heavy pulp feed is not perceptible, but after a while it is extremely diuretic in its effect, and we thought produced a malady from which a number of sheep died. We regarded seven pounds of pulp per day to lambs and ten pounds to sheep a maximum beyond which it is not safe to go, and concluded that it would be better to feed rather less pulp another year. Here are the figures:

Numbers and weight of sheep sold.

	Number.	Weight. Lbs.	Weight of wool. Lbs.	Total. Lbs.
Wethers	17,903	2,046,546	54,741	2,101,287
Ewes	3,646	387,350	574	387,924
Lambs	8,528	698,194	39,662	737,856
Totals	30,077	3,132,090	94,977	3,227,067

Average weights received and sold and gain.

	Weight received. Lbs.	Weight when sold. Lbs.	Gain. Lbs.
Wethers	94	117	23
Ewes	85	106	21
Lambs	58	86.5	28.5
All sheep	82	107	25

"The wethers were fed 150 days, the lambs were on feed 158 days, the ewes were on feed 126 days, so the average feeding period of all the sheep was 147 days.

"Number of sheep received, 31,048; number shipped, 30,077; sold at Ames, 35; on hand, 44; died, 892; total, 31,048. Per cent of deaths was 2.87. Total grain fed was 4,775,084 pounds; hay fed, 7,871,000 pounds; grain per head, 155 pounds; hay per head, 255.5 pounds. The total pulp fed was 11,971 tons. Average grain per head per day was 1.054 pounds; average hay per head per day, 1.73 pounds; average cost per head was $1.7728; cost per pound of gain, 7.9 cents."

At the Cornell Experiment Station an experiment was conducted with two lots of milch cows to study the value of beet pulp, in 1898, and repeated in 1899. The conclusions from the experiments are thus stated by the authors of the bulletin, Prof. H. H. Wing and Leroy Anderson:

"CONCLUSIONS.

"The cows, as a rule, ate beet pulp readily and consumed from 50 to 100 pounds per day, according to size, in addition to the usual feed of eight pounds of grain and six to twelve pounds of hay.

"The dry matter in beet pulp proved to be of equal value, pound for pound, with the dry matter in corn silage.

"The milk producing value of beet pulp as it comes from the beet sugar factory is about one-half that of corn silage.

"Beet pulp is especially valuable as a succulent food, and where no other such food is obtainable it may prove of greater comparative value than is given above."

REPORT OF SOUTH HAVEN SUB-STATION FOR 1901.

S. H. FULTON.

Prof. L. R. Taft, Horticulturist:

Sir—The following report upon the work of the South Haven sub-station for the year 1901 is herewith submitted:

The past season has been somewhat unfavorable for fruit, and the crop on the Station grounds has been lighter than for several years past. All kinds of fruit except the apple bloomed very full, but the set of fruit was light, probably due to cold wet weather during the blooming period. On the night of May 14, about one week after most kinds of fruit had come into blossom, a hard frost occurred which did considerable damage, particularly to currants, cherries and plums. Peaches yielded better than any other kind of fruit except the quince and the fruit was quite free from rot. Apples and pears were light in the case of most varieties, and the fruit was considerably damaged by the late brood of codling moth, in spite of the several sprayings made. Plums failed almost completely, and cherries were very light except for a few sour varieties which bore full or very nearly full crops. Grapes were rather light, but the fruit was of fine quality and unusually free from injury by insects or fungi. Small fruits, particularly raspberries and blackberries, suffered from the effects of very dry weather prior to and during the ripening period.

Results obtained by spraying were quite satisfactory, except in the control of the codling moth. These insects were very numerous and the second brood did considerable damage to late pears and apples. Leaf curl of the peach hardly made its appearance and grapes were very free from mildew. Arsenite of lime was again used in place of Paris green.

On the following pages tabulations of all varieties in fruiting this season are given, but general notes upon a large number of varieties are omitted, because of the unsatisfactory showing made. In the case of a number of kinds of fruit, descriptions of varieties which are considered most reliable and valuable for home and market purposes are appended in short lists to the more general notes given.

RASPBERRIES.

Raspberries failed to do well this season, owing to very dry weather prior to and during the fruiting season. Not only was the crop shortened, but the fruit was much smaller and of poorer quality than usual. The variety test proved so unsatisfactory under these conditions that descriptive notes upon all or nearly all kinds of fruiting, as given in former reports, will be omitted. However, with a view of aiding those desirous of securing information regarding the best varieties of raspberries to plant, descriptions of a number of the most reliable and profitable varieties for home and market purposes are given below. The accompanying tabulation is a list of all varieties in fruiting upon the Station grounds and a record of the behavior of each for the current year. The list is not materially different from that of last year. Several of the newer varieties as Coutant, Worthy, Egyptian and Brilliant are upon trial, but have not yet fruited.

RED VARIETIES.

Miller.—This is one of the first varieties to ripen and for some localities in Michigan it is the best of the early kinds. The plants are upright, moderately vigorous and usually quite productive. The fruit is roundish, slightly oblate, of good quality, sweet and pleasant, and is borne in quite large, rather compact clusters.

Marlboro.—The best early variety for this section. Plant vigorous and productive. Fruit large, firm, roundish conical, mild, sweet, of quite good quality. Fruits over a long season.

TABULATION OF RASPBERRIES, 1901.

ABBREVIATIONS: c, conical; o, oblate; ob, oblong; r, roundish; p, pubescent; b, blackish; pu, purplish; r, red; y, yellow.

Name.	Species.	Bloom.	First picking.	Last picking.	Product (1 10).	Form.	Color.	Average weight (ounces).	Quality (1-10).
Carman	Occidentalis	June 7	July 9	July 16	4	r	b	.025	6
Caroline	Neglectus	“ 14	“ 12	“ 18	6	r	y	.025	2
Centennial	Occidentalis	“ 10	“ 9	“ 19	5	r	b	.025	4
Church	Strigosus	“ 14	“ 12	“ 18	7	r	r	.05	8
Clark	Occidentalis	“ 7	“ 9	“ 16	4	r	b	.025	6
Columbian	Neglectus	“ 14	“ 15	“ 23	10	r	p	.062	6
Conrath	Occidentalis	“ 7	“ 9	“ 19	8	r	b	.037	5
Cromwell	Occidentalis	“ 14	“ 9	“ 12	2	r	b	.025	5
Cumberland	Occidentalis	“ 12	“ 13	“ 24	10	r c	b	.05	7
Cuthbert	Strigosus	“ 14	“ 13	“ 20	10	c	r	.05	6
Diamond	Occidentalis	“ 12	“ 15	“ 20	8	r	b	.025	7
Doolittle	Occidentalis	“ 12	“ 9	“ 18	7	r	b	.025	5
Earhart	Occidentalis	“ 7	“ 9	“ 12	2	r o	b	.025	6
Early King	Strigosus	“ 12	“ 9	“ 19	6	r o	r	.037	7
Emmet	Neglectus	“ 17	“ 12	“ 17	5	r	p	.025	3
Eureka	Occidentalis	“ 12	“ 9	“ 16	9	r o	b	.037	6
Farnsworth	Occidentalis	“ 7	“ 9	“ 18	5	r	b	.025	5
Golden Queen	Strigosus	“ 17	“ 13	“ 22	8	r c	y	.05	7
Gregg	Occidentalis	“ 12	“ 15	“ 22	8	r o	b	.037	8
Green	Occidentalis	“ 12	“ 9	“ 18	6	r	b	.025	7
Hansell	Strigosus	“ 14	“ 9	“ 20	5	r c	r	.037	6
Herstine	Idaeus hyb. (?)	“ 14	“ 9	“ 22	6	r o	r	.075	10
Hilborn	Occidentalis	“ 12	“ 9	“ 20	6	r o	b	.025	6
Idaho	Occidentalis	“ 12	“ 15	“ 22	8	r o	b	.037	6
Indiana	Occidentalis	“ 10	“ 9	“ 18	5	r o	b	.025	5
Johnston	Occidentalis	“ 12	“ 12	“ 17	4	r o	b	.025	7
Kansas	Occidentalis	“ 12	“ 9	“ 16	5	r o	b	.025	6
Livingston	Occidentalis	“ 14	“ 15	“ 22	8	r o	b	.037	5
Logan	Vit. x Idaeus (?)	“ 7	“ 5	“ 20	5	c	r pu	.12	5
Loudon	Strigosus	“ 21	“ 15	“ 22	8	r	r	.05	5
Marlboro	Strigosus	“ 14	“ 9	“ 20	5	r c	r	.05	6
Miller	Strigosus	“ 14	“ 9	“ 18	6	r o	r	.025	8
Mills No. 15	Occidentalis	“ 14	“ 15	“ 22	7	r o	b	.037	6
Munger	Strigosus	“ 21	“ 15	“ 22	8	r c	r	.05	4
Muskingum	Neglectus	“ 17	“ 15	“ 22	6	r o	p	.05	5
Nemaha	Occidentalis	“ 14	“ 15	“ 20	7	r o	b	.025	6
Ohio	Occidentalis	“ 7	“ 9	“ 19	7	r o	b	.025	6
Older	Occidentalis	“ 12	“ 12	“ 18	6	r o	b	.025	5
Onondaga	Occidentalis	“ 12	“ 15	“ 20	7	r	b	.025	6
Palmer	Occidentalis	“ 10	“ 9	“ 19	8	r	b	.025	7
Phœnix	Strigosus	“ 14	“ 15	“ 20	7	r o	r	.037	7
Redfield	Neglectus	“ 21	“ 15	“ 22	7	r	p	.025	3
Shaffer	Neglectus	“ 21	“ 15	“ 23	8	r	p	.05	6
Smith Giant	Occidentalis	“ 14	“ 15	“ 22	8	r	b	.05	6
Smith Prolific	Occidentalis	“ 12	“ 9	“ 20	7	r o	b	.025	9
Souhegan	Occidentalis	“ 12	“ 9	“ 18	4	r o	b	.025	7
Strawberry-raspberry	Rosaefolius	“ 21	“ 22	Aug. 20	10	c	r	.2	2
Turner	Strigosus	“ 14	“ 9	July 20	10	r c	r	.037	9
Tyler	Occidentalis	“ 10	“ 9	“ 14	4	r	b	.025	6
Winona	Occidentalis	“ 10	“ 9	“ 18	3	r o	b	.025	5

Cuthbert.—An old well-known variety and ordinarily the most reliable and profitable red raspberry grown. The fruit is large, conical, attractive in appearance, and of a sprightly, vinous flavor. The plants are upright, slightly spreading, vigorous and very productive. No other red raspberry in the Station collection has made so good a showing year after year as the Cuthbert.

Golden Queen.—A golden-yellow variety belonging to the same species as the red sorts. Very similar to Cuthbert in growth of plant, and in shape and size of fruit. This berry is of very good quality and for home use it is considered desirable. Should not be planted for market.

BLACK CAPS.

Eureka.—One of the most profitable early varieties in the Station collection. The plants are moderately vigorous and stand drouth well. The fruit is large and of good quality. Holds out well in size to close of season.

Kansas.—An early variety largely planted for commercial purposes. The plants are strong and vigorous. The fruit is of medium size, roundish oblate, and is borne in large compact clusters. Sometimes inclined to run small toward the close of the season, particularly if the weather is dry.

Conrath.—A bushy, vigorous grower, quite productive of large, roundish berries, which have quite good quality, although a trifle sour. A profitable variety, ripening a few days in advance of Gregg.

Gregg.—Medium to late; grown largely for market. The fruit is large, blue-black in color, of good quality. Plants upright, strong and vigorous, but not fully hardy. One of the most profitable kinds grown.

Cumberland.—A new variety highly recommended and already widely disseminated. The plants are stocky, vigorous and productive. The fruit is very large, roundish conical, firm, of very good quality. Ripens with the later varieties and continues in fruiting over a long season. The Cumberland has borne three successive crops upon the Station grounds and it appears, in all respects, worthy of the high praise it has been given.

PURPLE CAPS.

Columbian.—The best of the hybrid or purple cane class. Particularly valuable for culinary purposes. The plants are very strong, vigorous and productive. Fruit large, roundish-conical, borne in large, moderately compact clusters. Profitable for market where the quality of the fruit is known.

Shaffer.—Similar to Columbian in most respects, but not equal to the latter for profit. Has the fault of crumbling somewhat in picking, but otherwise it is a good berry. The plants have grown vigorously and produce abundantly upon the Station grounds.

BLACKBERRIES.

The early varieties of blackberries were considerably affected by the drouth, but rains occurred in time to save the later kinds and some very fine late berries were secured. Early King was the most productive of the early varieties, but the berries were smaller than usual because of the dry weather. Ohmer made the best showing among the late kinds. Wallace, which has proven one of the best and most profitable varieties on trial, again bore some very fine fruit, but the crop was not so large as usual. The varieties in fruiting were the same as those described in the report of last year. Below are given descriptions of varieties which are particularly desirable for the home and market.

NOTES ON VARIETIES.

Early Harvest.—This variety is largely grown for early market. The plants are upright growers and usually quite vigorous although somewhat tender. The fruit is of medium size, oblong, of good quality.

Early King.—A good early variety, frequently excelling Early Harvest upon the Station grounds. The plants are erect, moderately vigorous and usually quite productive. The fruit is ovate, irregular in shape, of good quality and pleasant vinous flavor.

Eldorado.—A new variety, resembling Snyder in leaf and habit of growth. The fruit is above medium in size, oblong-conical in shape, and of a vinous, pleasant flavor. In some respects this variety seems to be slightly superior to the old Snyder. Upon the Station grounds the yield during the past three years has once or twice excelled that of the Snyder, and the size of the fruit has been a little larger.

Kittatinny.—A large, attractive berry, of good quality. The plants are vigorous, fairly hardy, and usually quite productive. Although in some localities this variety seems especially liable to the attack of red rust, it is in most respects a desirable variety to plant.

Minnewaska.—A strong grower, quite productive of berries of large size and good quality. A few days later than Snyder in time of ripening. Although slightly lacking in hardiness, it is usually considered a valuable variety for general planting.

Ohmer.—One of the best of the late blackberries. This summer, Ohmer surpassed all other varieties of its season in productiveness, size and quality of fruit. The plants are spreading, rather slender growers, sometimes slightly lacking in productiveness.

Snyder.—An old, well-known variety, more extensively grown than any other kind. Its points of superiority are hardiness, vigor and productiveness. In planting for market purposes, Snyder is a good variety to rely on for the bulk of the crop.

Wallace.—This large, attractive berry has made an excellent showing upon the Station grounds. Last season it proved the most profitable berry in the Station collection. This season the fruit was very fine, but the crop was not quite so large as could be desired. The plants are upright, stocky and very vigorous. This variety comes from Wisconsin and does not appear to be very widely disseminated.

Wilson.—A profitable market variety, ripening slightly in advance of Snyder. Plants moderately vigorous, inclined to be tender. The berries are of large size, irregular, oblong in shape and of fair to good quality.

TABULATION OF BLACKBERRIES, 1901.

ABBREVIATIONS: **i, irregular; o, oblong; ov, ovate; r, roundish; b, black.**

Name.	Bloom.	First picking.	Last picking.	Product (1-10).	Form.	Color.	Average weight (ounces).	Quality (1-10).
Ancient Briton	June 12	July 30	Aug. 10	10	o	b	.075	7
Child's Tree	" 17	" 30	" 9	4	r, ov	b	.082	5
Early Harvest	" 21	" 20	July 29	1	o	b	.05	6
Early King	" 14	" 20	" 31	8	o	b	.05	7
Early Mammoth	" 10	" 26	Aug. 5	10	o, i	b	.075	7
Eldorado	" 12	" 26	" 9	8	o	b	.075	7
Erie	" 12	" 27	" 9	8	o	b	.125	7
Kittatinny	" 14	" 27	" 10	6	o	b	.1	6
Knox	" 14	" 26	" 10	7	o, i	b	.1	7
Lawton	" 14	" 26	" 9	6	o	b	.125	7
Lincoln	" 12	" 30	" 14	10	o, i	b	.05	7
Maxwell	" 14	" 20	" 3	4	o	b	.087	6
Minnewaska	" 14	" 30	" 14	6	r, o	b	.093	7
Nevada	" 14	" 23	" 14	6	o	b	.1	9
Ohmer	" 12	" 27	" 14	10	r, ov	b	.125	6
Oregon	" 27	Aug. 19	Sept. 15	10	ov	b	.075	5
Piasa	" 12	July 26	Aug. 3	2	o	b	.05	6
Reyner	" 12	" 30	" 9	10	i, o	b	.075	6
Sanford	" 10	" 30	" 14	10	o	b	.04	5
Snyder	" 10	" 26	" 14	10	r, ov	b	.05	7
Taylor	" 12	" 30	" 10	9	r, o	b	.087	9
Thompson	" 12	" 30	" 9	8	i, o	b	.087	7
Triumph	" 13	" 28	" 14	4	r, o	b	.05	7
Wallace	" 14	" 30	" 6	6	i, o	b	.1	8
Wilson	" 12	" 27	" 9	9	i, o	b	.087	5
Wilson, Jr	" 12	" 27	" 9	9	i, o	b	.1	5

CURRANTS.

The currant crop this season was cut short by a hard frost on the night of May 14. The frost occurred about one week after most varieties bloomed. No variety bore a full crop, and in the case of all kinds the bunches were loose and scraggly. Descriptive notes upon the further behavior of the various kinds upon trial are therefore omitted and in their stead are given descriptions of a number of varieties upon trial which have proven reliable and valuable, with slight exceptions, year after year. These varieties are recommended for general cultivation.

NOTES ON VARIETIES.

London.—One of the most profitable market varieties grown. The plants are tall, upright, slightly spreading and very productive. The berries, which are of good size, are borne in medium to long compact clusters. The quality of the fruit is not high.

Versaillaise.—A good home and market variety. The plants are fairly vigorous and quite productive. Berries above medium in size and of good quality; clusters long and compact.

Victoria.—An old variety largely grown for market. The plants are clean, thrifty growers, with thick, leafy foliage. Berries of good quality, but rather small; clusters medium to long, moderately compact. This season Victoria excelled all other varieties in productiveness and in compactness of bunch.

White Dutch.—A white currant of best quality. Valuable for home use only. Plants tall, vigorous and very productive. Berries large; clusters moderately large and compact.

Wilder.—This variety is of the Cherry type, but a better grower than Cherry, more productive and less subject to the attack of the twig borer. Plants tall, vigorous, uprigh, slightly spreading. Bunches large, long and compact; Berries large, of good quality. Yields more fruit than Cherry or Fay.

TABULATION OF CURRANTS, 1901.

ABBREVIATIONS: Form—r, roundish. Color—b, black; r, red; w, white. Use—d, dessert; k, kitchen; m, market.

Name.	Origin.	Planted.	Bloom.	Ripe.	Product (1-10).	Form.	Color.	Quality.	Vigor.	Weight in ozs.	Use.
Cherry	Europe	1888	May 7	July 8	2	r	r	5	7	.075	k, m
Fay	New York	1888	" 7	" 8	1	r	r	5	5	.1	k, m
Holland	Europe	1889	" 8	" 8	1	r	r	4	7	.05	k
Lakewood	Ohio	1890	" 7	" 8	1	r	r	6	7	.075	k, m
Lancaster		1898	" 7	" 8	5	r	w	8	7	.1	d, m
London	England	1890	" 6	" 8	6	r	r	5	10	.125	k, m
North Star	Minnesota	1890	" 7	" 8	5	r	r	8	10	.075	k, m
Pomona	Indiana	1897	" 7	" 8	5	r	r	7	7	.1	k, m
Red Dutch	Europe	1888	" 7	" 8	7	r	r	5	9	.075	k, m
Ruby Castle	Europe	1892	" 7	" 8	7	r	r	5	9	.075	k, m
Ruby, Moore	New York	1890	" 7	" 8	2	r	r	8	6	.1	k, m
Select	Massachusetts	1890	" 7	" 8	2	r	r	5	7	.1	k, m
Versaillaise	France	1888	" 7	" 8	4	r	r	6	8	.075	k, m
Victoria	England	1888	" 7	" 8	8	r	r	6	9	.075	k, m
White Dutch	Europe	1888	" 7	" 8	5	r	w	10	9	.075	d, m
White Gondoin	Europe	1890	" 7	" 8	4	r	w	9	7	.05	d, m
White Grape	Europe	1888	" 7	" 8	4	r	w	8	9	.05	d, m
Wilder	New York	1890	" 7	" 8	6	r	r	5	10	.15	k, m

GOOSEBERRIES.

With the exception of a few English varieties, gooseberries did as well as usual this season. Champion, Chautauqua, Lancashire and Orange were the most productive of the English varieties. Chautauqua made the best showing of any of the varieties of this class. Among the American kinds Downing, Pearl and Red Jacket gave the largest yield. Pearl and Red Jacket are promising new varieties. This season they bore fruit a little larger than that of the Downing, but were a trifle less productive. The plants of these two varieties do not quite equal Downing in vigor.

Liver of sulphur, one ounce to three gallons of water, was again used, as for several seasons past, for the prevention of mildew, which is especially liable to attack the English varieties. The first application was made May 1, and was followed by others at intervals of ten days until the fruit ripened. The disease appeared in June, but only to a slight extent, upon two or three English varieties.

ENGLISH VARIETIES.

Apex.—This variety has usually done well upon the Station grounds. The plant is a good grower and quite productive. Berries large, greenish-yellow, of good quality.

Champion.—A good, thrifty grower and quite productive, but the berries are usually quite small and rather sour. This season the fruit was larger and of better quality then formerly. The berries are greenish-yellow in color.

Industry.—A well-known variety. Quite subject to mildew. Lacks vigor and productiveness. Turns red when ripe, which is an objection to it for market purposes.

Orange.—Desirable for home use but of no value for market. The tallest, strongest grower on trial. The fruit is small, yellowish, thin-skinned, of best quality. Fine for culinary purposes, because of thin skin and high quality.

Triumph.—Plant vigorous and moderately productive. Fruit large, greenish-yellow, of good appearance. This variety is very similar to Columbus.

AMERICAN VARIETIES.

Houghton.—An old variety once considerably grown for market, but now almost entirely replaced by larger kinds. Plant strong, vigorous and moderately productive. The fruit is of very good quality, but quite small.

Pale Red.—A small reddish-green variety of very good quality. The plants are vigorous, but only moderately productive. Undesirable because of the small size of the fruit.

Smith.—A shy bearer, and a poor, weak grower. Drops its foliage badly in midsummer. Berries oval, green, of medium size and good quality. Not valuable.

Tree.—The plant is a strong, vigorous grower, but a poor bearer and the fruit is quite small. A failure here.

BEST VARIETIES FOR HOME AND MARKET.

Chautauqua (English).—This variety annually makes the best showing of any variety of its class on trial. This season the plants were loaded with large, perfect berries, free from mildew. The fruit is greenish-yellow in color, and quite attractive in appearance.

Columbus (English),—A good grower and usually quite productive. The berries are large, yellowish-green, of very good quality. Although more susceptible to mildew than some other of the English kinds, this variety gives very satisfactory results if properly cared for.

Downing (American).—An old, well-known variety, largely grown for market purposes. Unsurpassed by any of the newer American kinds. The plants are very vigorous and productive. Berries medium to large, greenish-yellow, of good quality. If other kinds are set, this variety should at least be planted for the bulk of the crop.

Keepsake (English).—Unsurpassed by any variety on trial for size of fruit. Single specimens sometimes weigh one-half ounce. Plant a medium grower, quite productive. Fruit yellowish-green, of good quality. While this variety does not always give uniformly good results, its behavior is usually very satisfactory.

Lancashire (English).—A vigorous grower and very productive. Berries large and of good quality. The fruit should not be left too long upon the plants, as it turns red when ripe. One of the best except for color.

Pearl (American).—Similar to Downing in fruit, but the plants are not quite so vigorous as that variety. This season Pearl did not quite equal Downing in productiveness, but made a very good showing.

Red Jacket (American).—The most promising new variety on trial. Fruit averages a little larger than Downing, but otherwise is similar to that variety in appearance. This variety seems fully equal, if not superior, to Downing in all respects except plant growth. The latter is somewhat more vigorous, making a larger, stronger plant.

TABULATION OF GOOSEBERRIES, 1901.

KEY: Form—l, long; o, oval; r, round. Color—g, green; r, red; w, white; y, yellow.

Name.	Species.	Planted.	Bloom.	Ripe.	Form.	Color.	Weight in ozs.	Product.	Quality (1-10).	Vigor (1-10).
Apex	Grossularia	1893	May 7	July 6	o	y, g	.15	8	8	6
Champion	Grossularia	1891	“ 7	“ 6	r, o	y, g	.15	10	6	10
Chautauqua	Grossularia	1892	“ 7	“ 6	o	g, y	.175	10	8	9
Columbus	Grossularia	1894	“ 7	“ 6	o	y, g	.125	4	8	8
Downing	Oxyacanthoides	1888	“ 6	“ 6	r, o	w, g	.112	10	7	10
Houghton	Oxyacanthoides	1888	“ 6	“ 6	r, o	r	.05	5	10	10
Industry	Grossularia	1889	“ 7	“ 6	r, o	g, r	.15	7	7	7
Keepsake	Grossularia	1894	“ 7	“ 6	r	y, g	.15	8	8	7
Lancashire	Grossularia	1894	“ 6	“ 6	o	g, r	.175	9	8	8
Orange	Grossularia	1890	“ 6	“ 6	o	y, g	.075	10	10	10
Pale Red	Oxyacanthoides	1890	“ 7	“ 6	o	r, g	.05	5	9	10
Pearl	Oxyacanthoides	1890	“ 6	“ 6	r, o	g	.125	8	9	7
Red Jacket	Oxyacanthoides	1890	“ 6	“ 6	o	g, r	.125	9	8	8
Tree	Cynosbati	1892	“ 8	“ 6	o	g	.05	1	6	7
Triumph	Grossularia	1890	“ 7	“ 6	o	g	.15	5	8	8

CHERRIES.

Only a few varieties of cherries fruited this season, and, among the kinds which bore, only four or five produced full crops. The bloom was very profuse and the prospects for a crop in early May never appeared better, but owing to cold, wet weather and the frost of May 14, the set of fruit was very light. It is interesting to note, in the record of productiveness in the accompanying tabulation, that Northwest, Ostheimer, Suda and Wragg, dark-red cherries of the English Morello type, were the only kinds which bore full crops. Montmorency, Weir No. 2 and Richmond stand next in productiveness in the order named. The sweet cherries failed almost completely, so far as yield is concerned. Among the Dukes, Montrueil made much the best showing. Below are given descriptions of varieties which have proven satisfactory upon the Station grounds, and which are considered desirable either for the home or commercial orchard.

MORELLOS.

Richmond.—This variety is vigorous, very hardy and an abundant bearer. Makes a much better tree than Dyehouse. The fruit is roundish heart-shaped, dark scarlet in color, acid, juicy, rather soft, of fair quality. One of the most profitable kinds for early market.

Montmorency.—The best of all the sour cherries in the Station collection. Tree upright, with roundish head, vigorous and very productive. The fruit is large, roundish, crimson in color; stem one and one-half inches long; flavor vinous, sprightly, pleasant; texture tender. Particularly valuable for market purposes. Ripens soon after Richmond.

Wragg.—A late, dark-red cherry, very similar to English Morello. The tree is rather dwarfish with spreading, roundish head and is an abundant, annual bearer. The fruit is roundish heart-shaped; stem one and one-half inches long; color dark crimson; flesh and juice dark red; flavor acid, slightly astringent; texture firm. Valuable for late market.

DUKES.

A number of varieties of this group bear fruit of large size and fine quality, but all but two or three are so unproductive that they cannot be recommended for general planting.

Carnation.—A vigorous, upright, slightly spreading grower, usually quite productive. The fruit is large, dark red, of very good quality. Season late June, or early July. Stands next to Montrueil for productiveness.

Montrueil.—This is the most valuable Duke on trial. The tree is an upright, spreading, vigorous grower, and an abundant bearer. The fruit is roundish heart-shaped; stem one and one-half to two inches long; color dark red, approaching black when fully ripe; flavor subacid, very pleasant; texture tender, flesh and juice dark red; quality very good. Ripens over a long season; first fruits mature early in July. Unsurpassed for culinary purposes. This variety was received from Stark Bros. in 1891. It seems to be but little known.

TABULATION OF CHERRIES, 1901.

Names.	Species.	Planted.	Bloomed.	Ripened.	Weight in ozs.	Product (1-10).	Quality (1-10).	Vigor (1-10).
Baltavar	Avium	1894	May 6	July 2	.2	1	8	9
Dyehouse	Morello	1891	" 7	" 1	.1	1	5	8
Elton	Avium	1892	" 6	" 1	.15	1	9	7
Eugenie	Duke	1888	" 8	" 1	.15	1	8	7
King	Morello	1891	" 7	" 1	.1	3	7	9
Lancaster	Morello	1894	" 8	" 1	1	2	6	9
Lithaur	Morello	1892	" 11	" 20	.075	2	5	10
Mary Kirtland	Avium	1891	" 6	" 1	.15	1	8	7
May Duke	Duke	1888	" 7	" 1	.116	1	8	9
Montmorency	Morello	1891	" 7	" 11	.125	8	7	10
Montrueil	Duke	1891	" 7	" 9	.1	6	9	9
Napoleon	Avium	1892	" 6	" 1	.175	1	8	9
Northwest	Morello	1893	" 10	" 20	.1	10	5	8
Ostheimer	Morello	1893	" 10	" 20	.1	10	4	8
Richmond	Morello	1892	" 10	" 1	.1	6	5	10
Sklanka	Morello	1888	" 10	" 1	.1	2	5	9
Spanish	Avium	1891	" 6	" 1	.15	1	10	8
Suda	Morello	1893	" 10	" 18	1	10	4	8
Weir No. 2	Morello	1891	" 1	" 1	.1	7	7	8
Windsor	Avium	1891	" 6	" 9	.15	1	7	9
Wragg	Morello	1892	" 8	" 20	.1	10	5	10

HEARTS AND BIGARREAUS.

Wood.—One of the best early varieties. Tree upright, spreading, moderately vigorous, quite productive. Fruit medium in size; color yellow, shaded with red; texture tender, quality very good. Valuable for home planting.

Yellow Spanish.—A large heart-shaped cherry, whitish-yellow, shaded with red, of very good quality. Tree vigorous and very productive. Well known. One of the best of the sweet cherries. Season late June and early July.

Napoleon.—An upright, spreading grower and an abundant bearer. Fruit very large, light yellow, handsomely shaded with bright, deep red; flavor sweet, excellent; texture very firm. Valuable both for home use and market.

Tartarian.—A close-headed, upright grower, and under ordinary conditions a regular, abundant bearer. Fruit large, heart-shaped; color black; texture half-tender, juicy; quality best. This variety does not show discoloration owing to the dark color of the fruit and is excellent for shipping purposes. One of the most profitable market varieties grown.

Windsor.—This variety was introduced from Canada a few years since and is now recognized as a very valuable cherry for market. The tree is upright, spreading, vigorous and a good bearer. Fruit large, heart-shaped; color dark red; quality very good.

PEACHES.

The peach made a better showing upon the Station grounds this season than almost any other kind of fruit on trial. Quite a large proportion of the varieties of bearing age bore full crops, and the fruit was very free from rot. This fall after the fruit had ripened a block of trees containing quite a number of the older, well-tested varieties was removed to make room for the subsequent planting of new kinds. The demand for space in the orchard is greater in the case of the peach than almost any other kind of fruit, because of the large number of new varieties introduced annually.

NEW VARIETIES.

Connett, Ford New, Longhurst, Oceana, Triumph and Waddell are new varieties which bore well this season. Connett is an attractive white peach, ripening in late August or in the season of Lewis. It is a larger, finer looking peach than Lewis, and while not so hardy as the later, it bears fully as well under ordinary conditions and is much more free from rot. Ford New and Oceana are large, yellow peaches, ripening with Engle Mammoth in early September. Both are very fine peaches, but coming as they do with Engle Mammoth, the latter a well-known, reliable variety extensively planted at the present time is to be preferred. Triumph bore fruit of a little smaller size than usual, but otherwise the crop was fully equal to that of last season. It is believed this variety may safely be recommended for planting when an early peach is desired, and especially for home use or local market. Waddell fruited for the first time this season. The tree is a stocky grower and evidently an early bearer, as the fruit procured was borne on two-year old trees. The fruit is creamy white, shaded with red, of good quality.

Sneed and Greensboro fruited for the second time this season and neither give any more promise of proving valuable than they did last year. Both are white peaches. Sneed ripens a few days earlier than Alexander. It is small and quite tender. Greensboro ripens with Early Rivers and is apparently no more desirable for market purposes than the latter variety.

SPRAYING.

Tests with copper sulphate solution of varying strengths, applied at different times for leaf curl, were again made as in former years. The first application was made November 23, 1900, with a view of testing the value of fall spraying. Commencing early in April trees which were purposely left untreated when the regular spraying was done were sprayed one row at a time, at intervals of a week up to the period of blossoming. The object of this treatment was to learn more definitely how close to the time of blossoming spraying might be done with a certainty of good results. With a view of testing the efficacy of a weaker solution of copper sulphate than is commonly used, one row of trees was sprayed with one pound of copper sulphate to one hundred gallons of water and another with one pound to two hundred gallons. The strength of material used in actual practice was one pound of copper sulphate to twenty gallons of water. In the case of all tests made, trees of the same varieties experimented on were sprayed early with the usual strength of copper sulphate and were used as checks.

The results of these tests are as follows:

Trees sprayed in southwest block November 23, 1900, showed a little more curl than trees sprayed in early spring. In the northeast block of trees, there was no difference between fall and spring sprayed trees.

On trees sprayed April 19, there was no more curl than upon trees sprayed April 12, at which time the regular spraying was done.

On trees sprayed April 26, there was a little more curl than upon trees sprayed April 12.

Trees sprayed May 3, showed in the case of some varieties, considerable more curl than trees sprayed April 12.

Trees sprayed early with one pound of copper sulphate to one hundred gallons of water showed no more curl than trees sprayed at the same time with one pound of copper sulphate to twenty gallons of water.

Trees sprayed early with one pound of copper sulphate to two hundred gallons of water also came through as well as trees sprayed early with the strength used in actual practice.

PRUNING.

With a view of studying the effects of fall and winter pruning of the peach, single trees of about twenty-five varieties were pruned in late fall and early winter. Trees of the same varieties were left unpruned until spring to serve as checks. No difference could be detected during the season between the fall and winter pruned trees and those pruned in the spring, either in the crop or in the trees themselves. However, much may depend upon the severity of the winter weather to which the trees are subjected after being pruned and a test of this kind to be valuable should be carried on for several years.

NOTES ON VARIETIES.

Albright.—Roundish slightly elongated, creamy white with blush, tender, of good quality. Too unproductive to be of value.

Allen.—Tree upright, vigorous, quite unproductive. Fruit roundish, smooth, yellow, free, of large size and good quality. Middle of September.

American Apricot.—A roundish, smooth, yellow amber peach of good quality, ripening in late September. Inclined to be undersized even when well thinned.

Amelia.—A large attractive white peach ripening in late August and early September. Lacks hardiness and productiveness.

Amsden.—An early white peach representative of the type to which belong Alexander, Early Canada, River Bank and others. Varieties of this class are of poor quality, soft and perishable, and although found in most of the old orchards, they are but little planted at the present time.

Bequette.—A very large, white peach of the Elberta type. Has made a good record here, but ripening as it does with Elberta, the latter is preferred, since it is yellow-fleshed.

Berenice.—A pale yellow peach of large size and good quality, but of poor appearance. Late September.

Bickell.—A late, white, free stone of medium size and poor quality. Ripens with Salway. Not desirable.

Bonanza.—Large, white, free stone, ripening in October. Inclined to be unproductive.

Brunson.—Similar to Kalamazoo, although of distinct origin.

Brown.—A white peach very similar to Lewis. Hardy and productive. Season same as Lewis.

Champion.—Very large, white, handsomely colored, of best quality. Too tender to ship well. Makes few fruit buds here and is inclined to be a shy bearer. Early September.

Columbia.—Yellow, peculiarly marked with dull red, of poor quality. Early October.

Connecticut.—Originated in New England about fifteen years ago. Fruit small, yellow fleshed, of good quality. Very unproductive.

Coolidge.—A large, attractive, yellow peach ripening in late September. Tree a good grower, but very unproductive.

Corner.—Resembles the Chili in form and color, but ripens a few days earlier than that variety. Flavor similar to that of the Barnard. Not very productive.

Crosby.—Fruit round, yellow with red cheek, free. Inclined to run small. Tree spreading, vigorous and productive. Late September.

Crothers.—Bore a light crop this season, but has usually been quite productive. Fruit medium to large, white with red cheek, firm and of good quality. Originated in Kansas. Late September and early October.

Dennis.—Round, yellow, of good quality. Too small and unattractive to sell well along with larger, more highly colored varieties of its season. Middle of September.

Ede.—Resembles Elberta in shape, color and flavor, but is not so large. Quite subject to leaf curl. Ripens a few days earlier than Elberta.

Ford New.—A large, roundish, handsome yellow peach of good quality ripening the middle of September. Tree is a good grower and heavy bearer.

Ford I.—A large, white freestone, ripening about with Lewis. A little larger and more attractive than Lewis. Quite free from rot. Tree vigorous and productive.

Ford III.—Fruit large, white, of rather poor quality. Almost too late for this climate.

Ford Red.—Fruit large, oval; color creamy white with blush; texture tender; quality good. Resembles Ford I, but ripens a number of days later.

Foster.—One of the most attractive yellow peaches grown, but unfortunately it is tender in bud and a shy bearer. Late August and early September.

Great Western.—A large, white, clingstone of rather poor quality. Unproductive. October.

Greensboro.—A new peach from Greensboro, N. C. Fruit, medium in size, oval compressed; color white, delicately blushed with light red. Texture tender. Quality quite good. Ripens with Early Rivers and does not appear very promising for the north.

Husted 101.—A medium to large yellow peach quite irregular in shape and of rather unattractive appearance. Quality very good. A new variety planted in 1895. Has borne two good crops.

Infant Wonder.—Small white peach ripening early in September. Of very poor quality. No good here.

June Rose.—A showy white peach of rather tender texture, ripening in early September. Tree upright, vigorous and usually quite productive.

Kallola.—A creamy white peach of large size and good appearance, but of low quality. Not valuable. Late September.

Lorentz.—A large, yellow, oval-shaped peach, ripening with Salway. Lacks productiveness here.

Lovell.—Fruit large, roundish, compressed; color, yellow with red cheek. Quality good. Tree a good grower but an irregular bearer.

Lovett.—A late ripening, white peach of rather unattractive appearance and low quality. Not desirable.

New Prolific.—Fruit medium to large, yellow, of good quality. Ripens with Kalamazoo which variety it closely resembles.

Oceana.—A promising new variety ripening the middle of September. Fruit large, yellow with red cheek, free, of very good quality. Tree grows well and is quite productive.

Pallas.—Color, white with red blush; form, oval with pointed apex; size, medium; quality, fair to good. Of the South China race; origin, Georgia. Early September.

Red Cheek.—A well known variety grown to some extent for market. Fruit large, roundish; color, yellow with bright red cheek; quality, good. Quite subject to leaf curl. Late September.

Rivers.—A large, white peach, attractive in appearance, but of very tender texture. Formerly grown to quite an extent for market, but now rarely planted.

Smock X.—Ripens a few days in advance of Smock, but otherwise indistinguishable from that variety.

Smock (Hance).—Cannot be distinguished from Smock here.

Sneed.—New variety from Tennessee. Fruit small, roundish oval; color, creamy white with light red cheek; flesh tender, juicy; of fair quality; semi-cling. Ripens a few days earlier than Alexander. This variety apparently has little to recommend it aside from earliness.

Stark Heath.—Strongly resembles Heath Cling. Fruit large, white, of fair quality, ripening about the middle of October.

Stevens Rareripe.—Grown for market in some sections. Fruit medium to large, roundish ovate; color, creamy white with red cheek; flavor, vinous and sprightly. Late September.

Stump.—An old white variety formerly grown for market, but little planted at the present time. Tree vigorous but unproductive. Late September.

Toledo.—Fruit large, roundish; color, creamy white with red cheek; texture quite tender; quality good. An irregular bearer and otherwise undesirable. Middle of August.

Toquin.—Origin Toquin, Mich. Fruit yellow, occasionally with a dull red cheek; flesh moderately juicy, of good quality. Tree an early and profuse bearer, but fruit is inclined to be rather small.

TABULATION OF PEACHES, 1901.

ABBREVIATIONS: Form—c, compressed; o, oblate; ov, oval; r, round. Color—c, creamy; g, green; r, red; w, white; y, yellow. Adhesion—c, cling; f, free; s, semi-cling. Quality, 1-10—1, very poor; 10, best. Flowers—l, large; m, medium; s, small. Glands—g, globose; r, reniform.

Name.	Planted.	Bloom.		Glands.	Ripe.	Adhesion.	Weight of specimen in ounces.	Product (1-10).	Form.	Color.		Quality (1-10).
		Date.	Size.							Skin.	Flesh.	
Advance	1897	May 10	s	g	Aug. 27	s	3.7	2	r ov	w r	w	6
Albright	1890	" 10	s	g	Oct. 5	f	3.2	1	r	w	w	5
Allen	1890	" 10	s	r	Sept. 18	f	3.6	3	r	y r	y	7
American Apricot	1892	" 9	l	r	" 23	f	3	6	r	y r	y	7
Amelia	1890	" 10	......	r	Aug. 31	f	5.5	2	r	w r	w	8
Amsden	1890	" 10	l	g	July 30	c	3.2	1	r	r g y	w	4
Bequette	1890	" 8	m	r	Sept. 18	f	4.8	8	o	w r	w	5
Berenice	1894	" 10	s	r	" 14	f	3.4	7	ov	y	y	7
Bickell	1890	" 10	m	r	Oct. 9	f	2.6	1	ov	w r	w	4
Bishop	1890	" 10	m	g	Aug. 26	f	3.6	10	r	w r	w	8
Bonanza	1890	" 10	s	r	Oct. 9	f	2	8	ov	w r	w	5
Brunson	1894	" 10	m	r	Sept. 14	f	3.8	7	r ov	y r	w	7
Brown	1892	" 8	l	r	Aug. 31	f	3.2	10	r c	w r	w	6
Canada	1890	....	l	g	" 30	c	3	3	r	w r	w	5
Champion	1894	May 7	m	g	" 9	f	7	3	r	w r	w	10
Champion (Serrate)	1890	" 11	l	......	" 9	c	2	6	r	c w r	w	5
Columbia	1890	" 10	l	r	Sept. 30	f	3.4	6	r ov	y	y	2
Connett	1894	" 7	l	r	" 19	s	3.1	10	r ov	r w	y	7
Coolidge	1892	" 8	s	g	" 18	f	4.5	1	r ov	r y	y	7
Corner	1890	" 11	s	r	" 20	f	4.6	6	ov	y r	y	6
Crosby	1892	" 10	m	r	" 23	f	2.8	10	r o	y r	y	7
Crothers	1890	" 8	s	g	" 23	f	4.3	1	r ov	w r	w	7
Dennis	1890	" 10	l	g	" 18	f	2.2	8	r	y	y	7
Early Barnard	1890	" 10	s	r	" 9	f	4.2	10	r	y r	y	9
Ede	1890	" 10	m	r	" 18	f	3.1	9	ov	y r	y	6
Engle	1892	" 10	m	g	" 10	f	3.7	10	r ov	y r	y	9
Ford New	1894	" 7	m	g	" 9	f	5.4	10	r	y r	y	7
Ford Red	1894	" 7	s	r	" 9	f	3.8	10	ov	w r	w	6
Ford I	1894	" 7	l	r	Aug. 25	s	3.6	10	r ov	w r	w	7
Ford III	1894	" 11	s	r	Sept. 30	s	4.2	1	r ov	w r	w	5
Foster	1893	" 10	s	g	Aug. 31	f	4.2	1	r ov	y r	y	8
Gold Drop	1890	" 10	l	r	Oct. 1	f	3.3	8	r	y	y	8
Great Western	1893	" 8	s	r	" 9	c	3.6	5	r ov	w	w	4
Greensboro	1896	" 8	m	r	Aug. 14	s	3.1	10	r ov	w r	w	7
Husted No. 101	1895	" 8	s	r	Sept. 18	f	3.5	8	ov	y r	y	6
Infant Wonder	1892	" 8	m	g	" 11	f	3.2	8	ov	w r	w	3
Jacques Late	1890	" 10	s	g	" 30	f	3.6	2	r	c w r	c w	7
June Rose	1894	" 8	l	g	" 14	f	4.9	5	ov	w r	w	5
Juno	1894	" 7	l	r	Oct. 3	c	4.2	2	r	y r	y	5
Kalamazoo	1890	" 10	m	r	Sept. 18	f	3.8	8	r ov	y r	y	8
Kallola	1892	" 8	l	r	" 23	f	2.7	10	r ov	g w	w	3
La Fleur	1894	" 7	l	r	" 27	f	4.3	4	ov	y r	y	5
Lemon Free	1894	" 7	l	r	Oct. 3	f	4.3	6	r	y g	y	6
Lewis	1890	" 10	l	g	Aug. 29	f	2.8	10	r	r w	w	6
Longhurst	1894	" 7	l	r	Sept. 23	f	3.2	8	ov	r y	y	8
Lorentz	1895	" 8	s	r	Oct. 9	f	3.2	6	r ov	y r	y	7
Lovell	1892	" 8	s	g	Sept. 18	f	4.7	9	r o	r y	y	8
Lovett	1890	" 10	s	r	Oct. 8	f	4.3	1	r ov	c w	w	6
Magdala	1890	" 10	m	r	Sept. 6	f	3.4	1	r	w r	w	8
McCollister	1892	" 8	s	r	Oct. 1	f	4.8	7	r ov	y r	g	6
Muir	1890	" 10	s	r	Sept. 23	f	3.1	1	r ov	y r	y	7
Neil	1892	" 8	l	r	Oct. 8	f	2.9	10	ov	y	y	7
Oceana	1895	" 8	m	r	Sept. 14	f	4.5	8	r ov	y r	y	7
Oriole	1894	" 7	l	r	" 23	c	3.8	5	r ov	y r	y	5
Pallas	1894	" 10	l	g	" 6	f	3.1	9	r ov	g w r	w	7
Pickett	1890	" 10	r	r	Oct. 3	c	3 9	1	r ov	y r	y	5
Princess	1894	" 7	l	g	Sept. 25	f	5	1	r ov	c w r	c w	8
Prize	1892	" 8	s	g	" 23	f	5.2	4	r ov	y r	y	6
Prize I.	1890	" 10	s	g	" 23	f	5.2	5	r ov	y r	y	6

PEACHES.—*Concluded.*

Name.	Planted.	Bloom.		Glands.	Ripe.	Adhesion.	Weight of specimen in ounces.	Product (1-10).	Form.	Color.		Quality (1-10).
		Date.	Size.							Skin.	Flesh.	
Red Cheek	1893	May 10	s	g	Sept. 23	f	4.8	6	r ov	y r	y	5
Red Seedling	1893	" 10	l	g	Aug. 30	f	4	10	r	w r	w	6
Rivers	1890	" 8	l	r	" 16	s	3.1	6	r ov	w r	w	5
Salway	1890	" 10	s	r	Oct. 8	f	4.3	5	r	y r	y	8
Scott	1890	" 10	s	g	" 3	f	4.1	1	r	y r	y	7
Smock	1890	" 8	s	r	" 3	f	3.3	9	ov	y r	y	6
Smock X	1892	" 8	s	r	" 4	f	3.2	9	r ov	y r	y	6
Smock (Hance)	1890	" 10	s	r	" 6	f	3.4	1	ov	y r	y	6
Sneed	1896	" 7	l	r	Aug. 5	s	2.9	2	r ov	r w g	w	4
Spotswood	1894	" 10	l	r	Sept. 14	f	4.6	9	r ov	c w	w	5
Stark Heath	1892	" 8	s	r	Oct. 9	c	4	5	r ov	c w	w	3
Stevens Late	1890	" 10	s	r	" 9	f	2.8	6	ov	w r	w	6
St. John	1890	" 10	s	g	Aug. 26	f	4	1	r	y r	y	6
Strong	1892	" 7	s	g	" 5	f	2.9	2	r	c w	w	6
Stump	1890	" 10	s	g	Sept. 23	f	4.5	1	r ov	r w	w	6
Summer Snow	1894	" 7	l	r	" 27	c	2.9	10	r	w	w	2
Switzerland	1890	" 10	s	g	" 23	f	4.1	5	r	c w	w	7
Toledo	1894	" 7	m	......	Aug. 17	f	4.4	10	r	w r	w	6
Toquin	1892	" 10	l	r	Sept. 23	f	2	10	ro	y r	y	8
Triumph	1896	" 10	l	g	Aug. 13	s	3.9	10	r	y r	y	6
Troth	1890	" 10	s	g	" 28	f	4	4	r	w r	w	8
Waddell	1899	" 8	l	r	" 29	f	3.2	10	r	w r	w	8
Washington	1890	" 10	s	g	Sept. 23	f	4	1	r ov	r w	w	7
Willett	1894	" 7	l	r	" 18	f	5	8	o vc	y r	y	8
Yenshi	1896	....	......	g	" 28	s	2.8	1	r	w r	w.	7

Waddell.—A new variety which comes highly recommended. Two year old trees fruited on the Station grounds this season. They have made a heavy stocky growth and presented an attractive appearance when in fruit. Fruit roundish oblong, creamy white with blush; of very good quality. A trifle tender, yet should ship well with careful handling. Ripened this season with Lewis, August 29. As the trees get older the season of ripening will, no doubt, be a little earlier. Foliage dark green, thrifty, with reniform glands.

Wonderful.—Large, roundish, yellow, of good quality. Unproductive. Early October.

VARIETIES FOR HOME USE AND MARKET.

Barnard.—Fruit roundish, inclined to be a trifle small; color yellow nearly covered with dark red; flesh rich yellow, moderately juicy of good quality. Excellent for canning. Particualry desirable for home use, but frequently grown with profit for market.

Connett (Southern Early).—A large handsome white peach of the North China Group. One of the best early varieties in the Station collection. Ripens with Lewis, usually larger and more attractive than the latter. Not so hardy as Lewis, but quite free from rot to which Lewis is subject. Tree a good grower and quite productive.

Elberta.—A profitable market variety ripening about the middle of September. Fruit large, oval, slightly flattened; color yellow, blushed with red; texture, firm; quality, good but not high. Ships well and sells well in market. Should be sprayed to prevent leaf curl, to which the variety is subject.

Engle Mammoth.—Large, roundish, yellow, of very attractive appearance and fine quality. Very productive and one of the most valuable market varieties grown. Second week in September.

Gold Drop.—Round, golden yellow, of good quality, hardy and productive to a fault. When severely thinned it is one of the most profitable late market varieties. Late September and early October.

Kalamazoo.—One of the most profitable market varieties grown in Michigan. Hardy and very productive. Fruit medium to large, yellow, usually with red cheek. Middle of September.

Lemon Free.—A large greenish-yellow peach ripening about with Smock. Although not very attractive in appearance, the quality of the fruit is good and the trees are productive. Profitable for market.

Lewis.—A well-known Michigan seedling. Hardy and very productive. Fruit medium in size, white, shaded with red, of fair quality. Extensively grown for market. Late August.

Longhurst.—A new variety supposed to be a seedling of the Chili. Fruit large, oval in shape, yellow, shaded with red. Very similar to Chili in appearance, but a little larger and more highly colored here. Late September.

Salway.—One of the best late market peaches grown. Fruit large, yellow, with red cheek, fair to very good quality depending on the season. Fairly hardy and usually productive. Middle of October.

Smock.—An old variety well-known and much esteemed for late market. Color greenish-yellow, with a slight blush on exposed surface; quality quite good, but inclined to be a little sour. Wood brittle, easily broken by winds. Quite free from leaf curl. Early October.

St. John.—One of the first good yellow peaches to ripen. Tree a good grower, but does not make many fruit buds and hence sometimes fruits rather sparsely. Fruit large, roundish, yellow, beautifully shaded with red, of good quality. Desirable for home use and in many localities profitably grown for market. Late August and early September.

Switzerland.—Medium to large, white, freestone ripening in late September. Quite Similar to Stevens' Rareripe. Tree grows well and bears well. One of the most profitable white peaches grown for market. Stands shipment well.

Triumph.—Fruit medium in size, roundish; color, yellow well overlaid and blotched with dark red; flesh sweet juicy, quite good; semi-cling. Tree upright, spreading, vigorous, quite productive. Although one of the newer kinds, this variety has been quite extensively planted and is now well known. It proves better in most respects than the old varieties of its season and can safely be recommended for planting where an early variety is desired. Middle of August or about two weeks later than Alexander.

PEARS.

Quite a number of varieties of pears bore well this season. Ansault, Bartlett, Duchess, Howell, Kieffer, Seckel and Winter Nelis were amoung the more productive kinds. The later varieties, in particular, were somewhat damaged by the codling moth in spite of the several sprayings which were made, but the fruit was quite free from scab. Several varieties, among which were Clapp's Favorite and Idaho, were destroyed by blight. The trees were cut back repeatedly, blighted twigs and branches being removed, until it became apparent that they could not be saved, whereupon they were dug up and burned. Other trees were attacked, but the cutting out of affected branches saved them and the disease was finally checked in the orchard. No doubt the attack of blight was induced by the heavy growth which the trees made last season owing to the wet weather which occurred.

NOTES ON VARIETIES.

Ansault.—Ripens just before Sheldon and resembles that variety quite closely in appearance. Quality very good; texture tender, buttery and melting. The tree is an early, abundant bearer.

Barry.—California seedling by B. S. Fox. Tree is a spreading, moderately vigorous grower, inclined to be unproductive. The fruit is elongated, pyriform, slightly obtuse; color, yellow nearly covered with russet; texture, firm, fine grained; quality, poor. This variety is gaining popularity in the state from which it comes, but does not appear to be desirable here.

Bartlett-Seckel.—Fruit oblong pyriform; color, light yellow with red cheek, very attractive; texture, melting, buttery, slightly granular; quality, good. Better than Bartlett but lacks the richness and high flavor of the Seckel. Requires further trial.

Beauty (Summer).—Very strong upright grower, quite unproductive. The fruit is large, obovate, light yellow, occasionally with red cheek. The flesh is coarse, breaking, of poor quality. Rots at the core. Not valuable.

Boussock.—Large, roundish, obovate; skin, yellow netted and clouded with russet; flesh, creamy white, buttery, melting; quality good. The tree is an upright, spreading grower, only moderately productive here.

Dearborn.—Small and rather unattractive in appearance; color, light yellow; quality, poor. Sometimes rots badly. Not valuable here. August.

Desportes.—Inclined to rot at the core. Not valuable here. Size medium or a little below; color, greenish-yellow, blotched and specked with russet. Quality rather low.

Drouard.—Fruit large, roundish, pyriform; color, yellow, considerably russeted. Flesh creamy-white, tender, a trifle coarse and granular; flavor sweet and perfumed; quality good. Not very productive as yet, but otherwise promising for market. November.

Early Duchess.—Tree upright, vigorous. Promises to be productive. Resembles Duchess in flesh and color, but has a smoother surface. Ripens three weeks earlier. Appears to be desirable for early market.

Edmonds.—Tree upright, slightly spreading, an irregular bearer. Fruit obovate, obtuse, pyriform; color pale greenish-yellow, thickly dotted with gray dots; flesh white, fine-grained, juicy; quality good. Rather unsatisfactory here.

Esperen.—Tree upright, spreading, vigorous. Bore a full crop this season but ordinarily this variety is unproductive. Fruit medium or a little below, roundish, obtuse pyriform; color, light yellow, well covered with cinnamon russet. Quality fair only. Subject to blight. Not valuable here.

Fred Clapp.—Fruit, roundish, inclining to obovate; skin, clear yellow with few brownish patches; flesh, whitish-yellow, very juicy; flavor, rich, pleasant; quality very good. A productive variety of value for home use and market.

Gansel-Seckel.—Planted in 1892, thus far rather unproductive. The tree is an upright grower with roundish, bushy head. Fruit, roundish oblate, irregular; skin, yellow, well overlaid with cinnamon russet; flesh, white, juicy, melting, slightly granular; quality, good, not rich and with none of the spicy flavor of the Seckel. Requires further trial.

Jones.—Fruit, small, obovate, pyriform; color, yellow, russeted; quality, good. The tree is an upright grower, only moderately productive. Does not appear very desirable. October.

Kentucky.—A small, greenish-yellow pear of poor quality, ripening in September. Unproductive. Worthless here.

Kraus 41.—Tree upright, slightly spreading, quite unproductive as yet. Fruit, medium in size, pyriform; color, yellow; quality, poor. Late August. Appears to be undesirable.

Lawrence.—Fruit, obovate, pyriform; skin, yellow, slightly russeted; flesh, whitish, juicy, melting; quality, very good. Grown to some extent for market. October to December.

Longworth.—Fruit, medium, obovate, turbinate; color, light waxen yellow with many small russet dots, quality, poor; texture, firm, breaking, coarse and granular. Tree is an upright, vigorous grower. Worthless here.

Millett.—Tree upright, vigorous, quite productive; fruit, large, obtuse, pyriform; color, greenish-yellow, blotched with russet; texture, firm, breaking; quality, fair only. Fit for eating in November. Will keep all winter. Does not appear very desirable.

Mount Vernon.—Fruit, roundish, obtuse, pyriform; skin, yellow, well covered with russet; flesh, white, juicy, tender, melting; flavor, vinous; quality, good. Tree is a vigorous grower and usually quite productive. Desirable for home and market. October and November.

Reeder.—A smooth, fair growing pear, somewhat resembling Howell in general appearance. Trees upright, vigorous, moderately productive. Received from Stark Bros. in 1890. October and early November.

Rostiezer.—A valuable dessert pear. The tree is an open grower with stout, brownish shoots. Fruit rather small, obovate pyriform; color, dull yellowish-brown with reddish-brown cheek. Not very inviting in appearance but of best quality. Early September.

Rutter.—A desirable variety, ripening in October. The tree is a good grower and is moderately productive. Fruit, large, roundish pyriform; color, yellow, dotted and netted with russet; flavor, sweet, vinous.

Souvenir (du Congres).—A very large pear resembling Bartlett in appearance. Blows down badly in fall winds. Texture, tender, melting; quality, good. The tree is an upright, spreading grower, rather unproductive. Season early October.

Sterling.—Tree, vigorous, upright, moderately productive, free from blight. Fruit medium in size, turbinate; skin, yellow with brilliant crimson cheek; flesh, white, juicy melting; flavor, sweet; quality, good.

Zache.—A Chinese sand pear, apparently of no value except as a novelty. Fruit, roundish oblate, resembling an apple in appearance; color, orange with many light yellowish dots and specks; quality, poor; texture, coarse, crisp. The tree is a fine strong grower with large, thick, glossy leaves. Keeps all winter.

VARIETIES RECOMMENDED FOR HOME AND MARKET.

Summer.

Bartlett.—An old, well-known variety, very popular. Fruit, large, obtuse pyriform; color, yellow with red blush; flesh, whitish, buttery, juicy and high flavored. Tree a strong grower and an early abundant bearer. Late August and early September.

Bloodgood.—An old variety, rather unattractive in appearance, but of best quality. Size, medium, turbinate; color, yellow, well covered with brownish russet. A valuable dessert pear ripening in August.

Elizabeth.—Tree upright, vigorous, forming a compact shapely head; quite productive. Fruit, small, roundish-obovate; color, yellow, with bright red cheek, very attractive; quality, very good. A valuable early pear for home use. August.

Giffard.—A medium sized pear of good quality, ripening in August. In color the fruit in greenish-yellow, sometimes with a dull red cheek. Tree thrifty and productive. Valuable for home planting.

Autumn.

Bosc.—Fruit, large, pyriform; color, dark yellow, nearly covered with patches and dots of cinnamon russet; quality, best. The tree is a poor grower and succeeds best if top-worked upon some strong, straight-growing variety. A valuable variety for home or market. October.

Anjou.—A fine fall pear, but a shy bearer while young. Thirteen year old trees have fruited sparsely as yet. Fruit, large, yellow, often with a brownish-red cheek; texture, buttery, melting; flavor, sprightly, vinous. Valuable either for home use or market.

Duchess.—A very profitable market variety. Succeeds best as a dwarf. Fruit, large, oblong obovate; color, greenish-yellow, sometimes a little russeted; flesh, white, juicy, slightly granular; flavor, rich, vinous. Largely grown.

Howell.—One of the best fall market varieties. Tree a free, upright grower and an early, profuse bearer. Fruit, large, smooth, pyriform; color, light waxen yellow, with red cheek, very attractive; texture, melting; flavor, sweet, vinous, perfumed. September and October.

Kieffer.—A standard variety largely planted at the present time and much used for canning purposes. The characteristics which commend it to the commercial grower are vigor, early maturity and productiveness of the tree, and firmness, good keeping qualities and fine appearance of the fruit. Although in no sense a dessert pear, it is fairly good for eating raw when well ripened, and for canning purposes it is regarded with much favor since it holds together well when cooked and develops a good flavor. The tree is usually quite free from blight.

Seckel.—Tree upright, slightly spreading, with a compact shapely head. Fruit, small, obovate, slightly pyriform; skin, dull, yellowish brown, covered with cinnamon russet; flesh, juicy, tender, melting, buttery; flavor, rich, sweet, vinous; quality, best. Well-known. Valuable both for home use and market. September and October.

Sheldon.—Tree a fine grower and quite productive. Fruit, medium to large; color, greenish-yellow, covered with light russet; flesh, whitish, melting, very juicy; flavor, sweet, vinous, rich, aromatic. Excellent for home use, but almost too tender and perishable for market.

Winter.

Dana Hovey.—Tree upright, vigorous and productive. Fruit, small, obovate, obtuse, pyriform; skin, yellow, russeted; flesh, juicy, slightly granular, melting; flavor, sweet, rich, aromatic, rivaling Seckel. A valuable dessert variety. October to January.

Winter Nelis.—Tree a straggly, slender grower, but very productive. Should be top-worked on some straight growing variety. Fruit, medium in size; yellowish-green and russet; texture, tender, melting, buttery; flavor, rich, sweet, aromatic. One of the best winter pears. October to January.

TABULATION OF PEARS, 1901.

ABBREVIATIONS: Season—e, early; m, middle; l, late. Form—e, elongated; i, irregular; o, oblate; ob, oblong; obo, obovate; obt, obtuse; ov, ovate; p, pyriform; r, round; t, turbinate. Color—b, brown; c, crimson; g, greenish; r, red; ru, russet; w, whitish; y, yellow. Texture—b, buttery; f, firm; g, granular; m, melting; t, tender; br, breaking. Flavor—a, acid; m, mild; as, astringent; j, juicy, s, sweet; v, vinous; p, perfumed. Use—d, dessert; k, kitchen; m, market.

Name.	Planted.	Bloom.	Season.	Vigor.	Product.	Weight in oz.	Form.	Color.		Texture.	Flavor.	Quality.	Use.
								Skin.	Flesh.				
Angouleme	1891	May 11	Oct., Nov.	10	10	8	ob obo	y	w	b	m v	8	d m
Ansault	1889	" 14	e Oct.	7	10	3.1	obo p	y g r	w	m	v p	9	d m
Barry	1892	" 16	Dec., April.	6	2	6.35	e p obt	y r w	w	f	s v	4	d m
Bartlett	1891	" 11	m Sept.	9	8	4.2	obt p	y r	w	t b m	v	7	d m
Bartlett Seckel	1894	" 13	e Oct.	9	5	3.8	ob p	y r	w	b m	s b	8	d
Beauty	1888	" 10	e Sept.	10	5	5 9	obo	y r	w	b r	s	5	....
Bloodgood	1888	" 10	m Aug.	10	7	2.5	t obo	y r w	w	b m	s p	8	d
Bosc	1888	" 11	Oct.	10	1	5.3	p	y r w	w	m b	s j p	10	d m
Boussock	1891	" 11	m Sept.	10	1	5.2	r obo	y r w	w	b m	s j p	6	m
Buffum	1891	" 14	Oct., Nov.	10	1	2.9	ob obo	y	w	t b	s	6	d m
Dana Hovey	1888	" 16	Oct., Nov.	9	8	2.6	obo obt p	y r w	w	g m	s p	10	d
Dearborn	1891	" 11	Aug.	6	4	1.9	r p	y	w	m	s	4	d
Desportes	1891	" 11	e Aug.	6	1	3.2	p	g y	w	m	s	5	....
Drouard	1890	" 11	Nov.	9	2	7.2	obt p	y r w	w	t b m	s p	5	m
Early Duchess	1892	" 10	m Sept.	8	6	5.5	ob op	y r	w	t b m	v	7	m
Edmonds	1889	" 11	Sept., Oct.	10	5	6.7	obo obt p	g y	w	m	s j	6	d
Elizabeth	1891	" 11	l Aug.	10	6	2	r obo	y r	w	b	s p	8	d
Esperen	1891	" 10	Oct.	10	10	2.8	r obt p	y ru	w	t g m	v	5	....
Flemish	1891	" 10	l Sept.	10	2	6	obo obt p	y ru r	w	m	s j	7	d m
Fred Clapp	1888	" 10	l Sept., Oct.	10	10	5.4	r obo p i	y	w	b m	s	8	d m
Gansel Seckel	1892	" 13	Oct.	8	1	2.8	r o i	y ru	w	m	s	7	d
Giffard	1888	" 10	e Aug.	8	6	3.2	p	g y r	w	m	j v p	9	d m
Howell	1888	" 10	l Sept.	7	9	5.9	r p	y r	w	m	v	6	m
Jones	1897	" 11	Oct., Nov.	8	6	2	obo p	y ru	w	g br	v	6	d
Kieffer	1891	" 11	Nov., Dec.	10	9	4.2	rov obt p	y r	w	f b	s v	4	m
Kentucky	1891	" 11	m Sept.	10	1	3.6	t	y	w	c b g	v	3	....
Kraus 41	1893	" 10	l Aug.	6	2	3	p	y r	w	f	s	3	....
Lawrence	1888	" 10	Oct., Dec.	7	5	4.2	obo obt p	y	w	m	s p	9	d m
Longworth	1891	" 13	Sept., Oct.	10	8	3.9	obo t	y	w	f g	s	5	....
Lucrative	1888	" 11	m Sept.	9	3	3.6	obo p	y	w	m	s	9	d
Millett	1891	" 11	Nov., Dec.	8	10	2.8	obo obt p	y ru	w	f	v	5	....
Mount Vernon	1894	" 10	Oct., Nov.	10	2	3.9	r obt p	ru	w	t b m	s j v	7	m
Reeder	1891	" 11	Oct.	9	2	4.6	obt p	y	w	b m	v	6	m
Rostiezer	1888	" 11	l Aug.	10	8	1.9	obo p	y ru	w	b m	s v	10	d
Rutter	1892	" 10	Oct.	10	5	6.4	r p	y r	w	b m	s v	7	m d
Seckel	1888	" 13	Oct.	9	7	2.2	obo r p	y b ru	w	t b m	s v	7	m d
Souvenir	1890	" 11	Oct.	9	2	6	obo p	y	w	t m	v	5	m
Sterling	1888	" 10	m Sept.	10	1	4.5	t	y r	w	m	s	5	m
Winter Nelis	1888	" 16	Nov., Jan.	8	8	3	obo	y ru	w	t b m	s p	10	d m
Zache	1894	" 13	Nov., April.	10	6	7.8	r	y ru	w	g	m s	3	....

PLUMS.

But few varieties of plums fruited this season. This no doubt was largely due to the cold, wet weather and frost already referred to during the blooming period. But the crop was further shortened by the attack of curculios, which were unusually numerous and persistent. Lombard was the most productive variety in fruiting and the only kind which bore a full crop.

Just before the blossom buds opened, one tree of each variety of plums on trial was sprayed with Bordeaux mixture. This application was made for the purpose of testing its efficacy in the control of brown rot, but the setting of fruit was so light that the benefit, if any, could not be detected. Later spraying for the rot with a weak solution of copper sulphate was also planned, but was abandoned because of the light crop.

Below are given descriptions of varieties which have proven, after several years of trial, to be among the most reliable and profitable kinds in the Station collection. A number of these are now largely grown for the home and market and all are considered desirable for such purposes.

VARIETIES FOR HOME USE AND MARKET.

Red June.—The best early Japan plum on trial. The tree is a fairly vigorous grower and an abundant bearer. Fruit, medium in size, cordate, elongated at apex; color, red, attractive; quality, quite good; season, late July. Valuable for early market.

Abundance.—One of the best known and most extensively grown of the Japan plums. Tree readily distinguished by its upright, vigorous growth and reddish colored shoots. Fruit, yellow, shaded with red, somewhat tender, juicy, of good quality. Season early August.

Satsuma.—A vigorous, upright, spreading grower, usually quite productive. Fruit, large, roundish; color, dark, purplish red; texture, tender; flavor, mild, vinous. Flesh of this variety is dark purple. The best variety in the Station collection for culinary purposes.

Burbank.—A remarkably vigorous, spreading grower, very productive. Fruit, roundish, tapering slightly toward apex; color, dark red on yellow ground; texture, tender; adherence, cling; quality, good. Stands shipment well and is particularly valuable for market. Trees require severe heading in to keep them within bounds. Season late August.

TABULATION OF PLUMS, 1901.

ABBREVIATIONS: Form—l, long; o, oval; ob, obovate; r, roundish. Color—b, black; g, greenish; p, purple; r, red; w, whitish; y, yellowish. Adhesion—c, cling; f. free; s, semi-cling.

Names.	Species.	Planted.	Vigor.	Bloom.	Ripe.	Form.	Color.	Adhesion.	Weight of specimen in ounces.	Product.	Quality.
Arch Duke	Domestica	1893	9	May 7	Sept. 6	r o	b	f	1.3	2	7
Baker (Damson)	Domestica	1893	8	" 10	" 6	r	b	s	.25	1	6
Berckmans	Triflora	1897	10	" 10	Aug. 31	r	r	c	1.1	2	6
Chase	Triflora	1890	9	" 6	" 31	r o	y r	c	1.1	1	6
French Damson	Domestica	1893	8	" 11	Sept. 6	r	b	c	.5	3	7
Hale	Triflora	1896	10	" 6	Aug. 21	r	y	c	1.5	1	9
Lincoln	Domestica	1890	8	" 10	" 19	r o	r y	f	1.5	1	8
Lombard	Domestica	1889	9	" 7	Sept. 6	r o	p	c	.8	10	6
Red June	Triflora	1890	8	" 6	Aug. 3	r o	r	c	.9	1	7
Victoria	Domestica	1890	8	" 7	Sept. 5	o	y p	f	1.4	1	8
Wangenheim	Domestica	1890	10	" 13	Aug. 31	o	b	f	.7	4	6
Youngken	Cerasifera	1897	9	" 7	July 30	r	y	c	.4	4	5

EUROPEAN PLUMS.

Bradshaw.—A valuable early market variety, ripening the last of August. Tree upright, slightly spreading, vigorous, productive. Fruit, large, very attractive, oval, reddish purple, of good quality.

Lombard.—An old, well-known variety, extensively grown. Ripens at a time when plums are usually plentiful and most apt to be cheap. However, the Lombard sometimes fruits when nearly all other varieties fail, as has been the case this season, and it is desirable because of its hardiness and regularity of bearing. The fruit is medium to large, roundish oblong, purple in color, of good quality. Season early September.

Diamond.—A profitable late market variety. Usually but little subject to rot. The tree is an upright, slightly spreading, vigorous grower. Fruit, large, oval; color, black; quality, fairly good, though rather acid. Late September.

Grand Duke.—One of the newer sorts which has proven desirable for market purposes because of its large size and handsome appearance. Tree upright, spreading, vigorous, and quite productive. The fruit is oval, black with blue bloom, of good quality. Season late September.

Shropshire Damson.—A small, late, blue plum, valuable for preserving. This variety is always in demand and sells for a good price. The tree is an upright grower with dense head and slender shoots with many short, lateral spurs. These characteristics make the tree readily distinguishable.

Monarch.—One of the newer varieties, ripening in late September. The fruit is large, roundish ovate; color, very dark purple with blue bloom; texture, firm; quality, quite good, though rather acid. The tree is a good grower and a very abundant bearer. Like most of the late plums this variety usually escapes the brown rot. Very desirable for late market.

GRAPES.

The grape crop was not large this season, but the quality of the fruit was very fine. Insects and diseases hardly put in an appearance. The hybrid varieties, such as the Rogers' grapes, are usually very subject here to the attack of powdery mildew, but this season they were almost entirely free from the disease. The vines were sprayed in early spring, before growth commenced, with copper sulphate, one pound to fifteen gallons of water. After the fruit had set Bordeaux mixture was used, two applications being made.

Last spring a small block of forty-five varieties was removed, to make room for the subsequent planting of other kinds of fruit. The number of varieties on trial was thereby reduced from one hundred and fifty to one hundred and five. Most of the varieties removed were hybrids which, as a class, possess more or less undesirable characteristics here. Most of them fruit sparsely, mildew badly, and many of them are inclined to be tender, weak growers.

NOTES ON VARIETIES.

Agawam.—A large, dark-red grape, of good quality. Fruits sparingly and mildews badly here.

Alice.—Red, of poor quality, ripens unevenly. Rather late for this climate.

Belvidere.—Clusters cylindrical, usually shouldered; berry black, of fair quality. The vine is a rather weak grower and quite unproductive here.

Berlin.—A white grape of good quality, ripening in early October. Inclined to be unproductive.

Black Eagle.—Cluster large, long, conical, moderately compact. Color, black; quality, very good. Lacks hardiness and productiveness.

Burnett.—A black grape, ripening a few days earlier than Concord. Cluster oblong, shouldered, moderately compact. Subject to mildew and quite unproductive.

Caywood.—A black grape of low quality; shells badly; not valuable.

Centennial.—A small, white grape, about the size of Delaware. Quite productive, free from mildew and of best quality. Desirable for home use.

Duchess.—A good grower and usually quite productive. Clusters long, conical, shouldered, quite compact. A late keeping variety, desirable for home use.

Empire State.—A white grape borne in very long, cylindrical, shouldered clusters. Moderately productive and of quite good quality.

Esther.—A healthy, vigorous grower, moderately productive. Clusters cylindrical, shouldered, compact. A little lacking in juice and almost too mild in flavor. Late September.

Golden Gem.—A small, greenish-yellow grape of best quality. Clusters cylindrical, shouldered, compact. Desirable for home use.

Goldstein.—Very similar to Champion. Vine is a strong grower and very productive. Fruit shells badly and is of poor quality.

Guinevra.—A seedling of Salem resembling Niagara in appearance. A good grower and quite productive. Bunches large and very compact. Seems to be valuable. Received from C. Engle of Paw Paw. Early October.

Hosford.—Black grape of fair quality, ripening about the middle of September. Quite unproductive.

Iona.—A red grape of best quality. Season late. Ripens unevenly and cannot be relied on in this section.

Jessica.—One of the first varieties to ripen. Small, white, productive, of good quality. Desirable for home use.

Josselyn No. 5.—A white grape of good quality. The best of Josselyn's varieties on trial. Quite productive and of good quality. Late September and early October.

Josselyn No. 9.—A dark purple grape, borne in cylindrical, shouldered, moderately compact clusters. Of poor quality and almost too tender to stand shipment well.

Josselyn No. 10.—A black grape of medium size and fair quality. Very unproductive.

Lady.—A white grape of good quality, ripening about the middle of September. Clusters small, oblong, slightly shouldered. Sometimes bears well, but is inclined to be unproductive.

Lutie.—Clusters long, cylindrical, usually shouldered, very compact; berry large, dark-red; quality, fair only. Somewhat foxy.

Massasoit.—A strong grower, but rather unproductive. Bunches small and loose; berry red, of good quality. Mildews badly. September.

Merrimac.—A black hybrid grape, very subject to mildew; quite unproductive.

Millington.—Bunches roundish, shouldered, rather loose; berry very large, black, of fair quality. Quite unproductive. Middle of September.

Mills.—A tender variety which was frozen to the ground two years ago. Has just come into bearing again and this season matured a light crop of fruit of very good quality. Color, black; flavor, vinous, rich; quality, best; skin, tough and thick. A good keeper.

Moore.—An early black grape of good quality. A good grower, but rather unproductive here.

Osage.—A black grape of fair quality. Unproductive. Not valuable.

Peabody.—Bunches large, cylindrical, shouldered, compact. A grape of good quality, but quite unproductive and subject to mildew.

Pocklington.—A well-known, white grape. Not very desirable here. Middle of October.

Poughkeepsie.—A red grape of best quality, but a poor grower and quite unproductive here.

Requa.—A red grape, ripening the middle of September. Quite subject to mildew and anthracnose.

Rochester.—A reddish purple grape, borne in short, conical, shouldered, very compact clusters. Of low quality; quite foxy.

Telegraph.—An early black grape of poor quality. The vine is vigorous and quite productive; clusters very compact.

Triumph.—A vigorous grower and quite productive. The clusters are very large, long, cylindrical, shouldered, compact; berry greenish-white, rather acid and poor in quality as grown here. Almost too late for this climate.

Ulster.—A red grape of good quality, ripening in late September. Sometimes sets too much fruit and fails to ripen well. Bunches of medium size and quite compact. Desirable for home use.

White Imperial.—A medium-sized, white grape, of good quality. Clusters small. An irregular bearer. .

Wilder.—A black grape of good quality, ripening in late September. Subject to mildew and rather unproductive.

Willis.—An early, white grape of fair quality, borne in compact, shouldered clusters. Not very valuable.

Woodruff.—Vigorous grower and good bearer. Fruit, red, of variable quality, usually quite poor here. Inclined to set too much fruit, in which case it ripens imperfectly. Cannot be recommended.

Wyoming.—A medium-sized grape of poor quality, very foxy. Vine vigorous and hardy, but quite unproductive here.

TABULATION OF GRAPES, 1901.

ABBREVIATIONS—Bunch: Form—c, compact; cy, cylindrical; r, roundish; s, shouldered. Berry: Form—o, oval; ov, ovate; r, round. Color—a, amber; b, black; g, greenish; p, purple; r, reddish; w, whitish; y, yellowish. Season—b, beginning; m, middle; e, end.

Name.	Species.	Bloom.	Ripe.	Vigor.	Productiveness.	Quality.	Bunch.		Berry.		
							Form.	Weight in oz.	Form.	Size.	Color.
Agawam	Lab. x Vin	June 24	Sept. 26	8	2	7	cy s	1.9	r	8-9	r
Alice	Lab.	July 1	“ 26	10	4	7	cy s	2.6	r	5	r
Belvidere	Lab.	June 24	“ 5	6	3	7	cy s	2.5	r	5-6	b
Berlin	Lab.	July 1	“ 25	8	7	6	cy	3.2	r	6	w
Black Eagle	Lab. x Vin	“ 1	“ 14	8	10	7	cy s	4.4	r	6	b
Black Pearl	Lab. x Vin	June 22	“ 14	9	1	4	cy s	1.3	r	4-5	b
Brighton	Lab. x Vin	July 1	“ 26	10	10	10	cy s	6.4	r	7	r
Burnett	Lab. x Vin	June 29	“ 14	5	1	7	cy s	2.7	r	5	b
Campbell	Lab. Hybr	“ 26	“ 5	10	5	8	cy s	7.5	r	8	b
Caywood	Lab.	“ 29	“ 16	8	2	4	cy s	2.5	r	5	b
Centennial	Lab. x Vin	“ 24	“ 14	4	9	10	cy s	1.7	r	4	g y
Chidester No. 2	Lab.	“ 24	“ 14	9	3	8	cy s	2.9	r	7	r
Clinton	Vul. x Lab	“ 24	Oct. 1	10	6	4	cy s	2.8	r	4	b
Columbia	Vul. x Lab	July 1									
Concord	Lab.	June 29	Sept. 16	10	10	6	cy s	2.8	r	8	b
Delaware	Bour. x Lab	July 1	“ 16	5	4	10	cy s	2.1	r	2	r
Diamond	Lab. x	June 26	“ 16	10	2	8	cy sc	3.4	r	5	g w
Diana	Lab. x Vin	“ 29	Oct. 1	10	1	8	cy	1.9	r	5-6	r
Duchess	Lab. Hybr	July 1	“ 10	10	6	9	cy s	3.5	r	5	w
Early Victor	Lab. x	“ 1	Sept. 15	10	3	7	cy s	3.4	r	4	b
Empire State	Lab. x Rip	“ 1	“ 26	9	4	7	cy s	3.4	r	4	g
Esther	Lab. x	June 29	“ 25	8	7	6	cy s	3.1	r	5	g
Etta	Lab. x Vul	July 1									
Golden Gem	(Bour x Lab.) x Vin.	June 29	Sept. 14	5	3	10	cy s	7.8	r	3	g w
Goldstein	Lab.	“ 24	“ 3	8	6	4	cy s	2.6	r	5	b
Guinevra	Lab. x Vin	“ 26	“ 26	10	6	8	cy s	7.1	r	8	y g
Hosford	Lab.	July 1	“ 14	7	2	6	cy s	2.4	r	8	b
Iona	Lab.	May 29	Oct. 11	10	4	10	s	4.6	o	6	r
Jefferson	Lab. x	July 1	Sept. 26	8	5	9	r s	3.1	r	6	r
Jessica	Bour. x Lab	June 26	“ 6	9	5	7	cy s	1.2	r	5	w
Josselyn No. 5		“ 26	“ 30	6	8	9	cy s	3.4	r	8	w
Josselyn No. 9		“ 29	“ 30	3	6	9	cy s	3.6	r	5	r p
Lady	Lab.	July 1	“ 16	4	2	6	s	3.5	r	7	w
Lutie	Lab.	“ 1	“ 14	7	1	5	cy s	2.7	r	7	r
Mason	Lab. x Vin (?)	“ 1									
Massasoit	Lab. x Vin	“ 1	Sept. 16	9	1	7	r s	2.5	r	7	r
McPike	Lab.	“ 1	“ 20	8	7	6	cy s	3.9	r	4	b
Merrimac	Lab. x Vin	“ 1	“ 16	8	2	8	cy	2.5	r ov	6	r
Millington	Lab.	“ 1	“ 14	6	1	5	cy s	1.9	r	6	b
Mills	Lab. x Vin	June 29	“ 16	4	1	10	l s	3.5	r	5-6	b
Moore	Lab.	July 1	“ 6	5	1	8	cy	3.2	r	8	b
Niagara	Lab.	“ 1	“ 16	10	3	6	cy s	3.1	r	8	g w
Osage	Lab.	“ 1	“ 26	8	1	5	cy	4.2	r	8	b
Ozark	Aest	“ 1									
Pocklington	Lab.	“ 1	Oct. 1	9	4	7	cy s	3.8	r	7	g w
Poughkeepsie	Bour. x Lab	“ 1	“ 1	3	6	10	cy s	2.9	r	4	r
Progress		May 29	Sept. 14	6	4	6	cy s	2.7	r	5	b
Requa	Lab. x Vin	June 29	“ 14	8	10	8	cy s	3.3	r	7	r
Rochester	Lab.	“ 29	“ 20	8	2	4	c cy s	1.8	r	4	r
Telegraph	Lab.	“ 26	“ 5	5	3	6	cy s	3.7	r	6	b
Triumph	Lab. x Vin	July 1									
Ulster	Lab. x	June 24	Oct. 1	4	8	9	cy	2.6	r ov	6	r
Vergennes	Lab.	“ 28	Sept. 26	7	5	9	s	2.8	r ov	7	r
Warder	Lab.	“ 26	“ 5	5	3	4	cy s	2.2	r	6	b
White Imperial	Lab. x Vin. (?)	“ 29	“ 14	4	7	8	cy s	2.1	r	4	w
Wilder	Lab. x Vin	July 1	“ 16	10	2	8	cy s	2.6	r	9	b
Willis	Bour. x Lab. (?)	“ 1	“ 14	7	6	6	cy s	2.4	r	5	w
Woodruff	Lab. x										
Worden	Lab.	June 24	Sept. 16	10	10	8	s	3.7	r	8	b
Wyoming	Lab.	July 1	“ 16	10	1	4	cy	2.6	r	5	r

VARIETIES FOR HOME USE AND MARKET.

Brighton.—A well-known red grape of best quality, ripening in September. Somewhat variable in its behavior and frequently inclined to mildew, but under favorable conditions it is one of the best of the red grapes for home, or market.

Campbell.—A new early grape, of the Concord type. Vine is a vigorous grower; thus far, but moderately productive. Bunches large, shouldered, moderately compact; berry large, firm, thick-skinned, clings to stem well; quality very good. A promising variety except for the fact that the bunches fail to fill out well. Ripens with Moore and will keep several weeks. Does not shell like many of the early varieties. Requires further trial.

Concord.—Best known and one of the most reliable varieties grown. Vine a vigorous grower and very productive. Clusters cylindrical, shouldered, compact; berry, black, of good, but not high quality. Extensively grown for market. One of the most valuable varieties for this purpose.

Delaware.—The most valuable red grape grown in Michigan. Bunches cylindrical, shouldered, very compact; berry small, red, of best quality. Excels both for dessert and market purposes.

Diamond.—White grape of good quality, ripening just before Concord. Vine is vigorous and quite productive. Valuable for home use. Grown to quite an extent for market in some grape sections.

Jefferson.—A late ripening red grape, of very good quality. Keeps well for several weeks. Usually quite productive. Valuable for home use.

Vergennes.—Clusters long, slightly shouldered, compact; berry large, red, oval, of very good quality. Vine hardy, moderately vigorous, productive. Ripe in early October and will keep well for several weeks. Desirable for home use.

Winchell.—Sometimes known as Green Mountain. A valuable, early, white grape. One of the first varieties to ripen. Vine is a good grower and quite productive. Worthy of a place in every home collection.

Worden.—A well-known Concord seedling. Larger than Concord and of better quality. Valuable both for home and market. Ripens a few days earlier than Concord.

QUINCES.

The quince crop was good this season and the fruit was quite free from the attack of insect enemies and fungous diseases. A few trees, however, were attacked by blight during the summer. These were cut back severely in removing diseased branches and the disease did not reappear. Champion, Missouri and Rea were among the more productive varieties. Rea is a seedling of Orange and proves to be one of the most reliable and profitable kinds on trial.

NOTES ON VARIETIES.

Alaska.—A vigorous, hardy, productive variety, ripening about the middle of October. Fruit, roundish, slightly oblate; color, orange yellow; texture, crisp; quality, best. Smaller than Orange, but otherwise not very different from that variety.

Champion.—An upright, spreading, vigorous grower. Quite productive. Fruit, large, greenish-yellow, firm, crisp, of good quality. An early bearer. Season October and November.

Meech.—Below medium in size, very symmetrical in form, slightly pear-shaped. Vigorous and very productive. Not so desirable for market purposes as some of the larger fruited kinds.

Missouri.—Moderately vigorous and quite productive. Fruit very large, roundish, slightly oblate; color, yellow; texture, firm, crisp, juicy; quality very good. Season October.

Orange.—An old well-known variety more extensively grown than any other kind. A vigorous grower and abundant bearer. The fruit is large, clear orange yellow, attractive, of very good quality. The leading market variety. Season October.

Rea.—One of the newer kinds which may safely be recommended for general planting. It is a seedling of the Orange and is a larger and firmer quince than its parent.

Van Deman.—A good grower and abundant bearer. The fruit is medium to large, clear, rich yellow in color. Quite similar to Orange.

TABULATION OF QUINCES, 1901.

Name.	Planted.	Bloomed.	Ripe.
Alaska	1891	May 27	Middle of October.
Angers	1890	" 31	" " "
Bourgeat	1895	June 2	" " "
Champion	1888	" 2	Early November.
Fuller	1894	May 30	Middle of October.
Meech	1888	" 30	Middle of October.
Missouri	1891	" 23	Early October.
Rea	1888	" 27	" "
Van Deman	1895	" 29	Middle of October.

APPLES.

Results with apples this season were quite unsatisfactory. The crop upon many varieties was light and practically all of the fall and winter kinds were badly damaged by the late brood of codling moth. Early in April the trees were sprayed with copper sulphate, one pound to fifteen gallons of water, with the exception of one tree of each variety which was left unsprayed until the blossom buds were about to open when an application of Bordeaux mixture was made. The late spraying with Bordeaux is considered very beneficial by way of preventing the attack of the scab fungus which is particularly liable to appear during the blossoming period. This season scab was not very prevalent, and the benefit derived from the Bordeaux spraying was not so great as expected. One-half of the trees sprayed just before blossoming time with Bordeaux mixture, were given an extra spraying with this fungicide during the season, making in all four applications of Bordeaux following the setting of the fruit. All other trees were sprayed three times after blossoming with Bordeaux. The object of the fourth spraying above referred to was to test the value of late spraying for the second brood of codling moth. The moths were unusually numerous and persistent in their work and the late varieties were quite wormy in spite of the spraying. The extra application apparently did little, if any good.

The poison used in connection with the Bordeaux mixture was arsenite of lime which was also used last season. The crop of a year ago was remarkably free from worms. Quite likely the poor success met with this season in the attempt to control the codling moth was due to the fact that the insects were present in unusually large numbers rather than to any possible difference in the way the poison was prepared, or to any slight variation in the time the applications were made.

NOTES ON VARIETIES.

Arnold.—Tree a good grower and quite productive. Fruit, medium to large, yellowish-white, of good quality. Season November to March. Too light in color and almost too tender for market; promising for home use.

Babbitt.—A large, roundish, oblate, striped apple of good quality; very productive. Resembles Wagener somewhat in appearance, but ripens before that variety and the tree is a more vigorous grower. A good late fall and early winter variety.

Bietigheimer.—A large, beautifully colored apple from Germany. Quality very poor. Not valuable. Late August and early September.

Bishop Bourne.—A sweet apple from Nova Scotia claimed to be very hardy. Fruit, roundish, conical, light yellow, splashed and striped with red; quality, fair only. Does not appear very promising.

Bottle Greening.—A handsome apple of good quality. Large, greenish-yellow, shaded with dull crimson; rather tender for market, but a fine dessert fruit.

Bradford.—A peculiarly marked dark red apple of medium size and firm texture. Quality, rather low. December to March.

Buckingham.—Tree upright, slightly spreading, vigorous and productive. Fruit, large, oblate, conical; color, greenish-yellow, shaded and splashed with two shades of red; quality, fair to good. November to February.

Canada Baldwin.—A richly colored apple of medium size and very good quality. Resembles Snow in appearance and flavor. Of Canadian origin. Said to be a valuable winter apple in the locality from which it comes. December to April.

Chenango.—A well-known dessert apple, ripening in late August and early September. Fruit, medium to large, oblong, conical; color, whitish-yellow, washed and striped with bright red.

Colton.—Resembles Primate somewhat in flavor and ripens in same season. Fruit, medium, ovate, conical; color, greenish-white, usually with russet patches; quality, good. A good grower and an abundant bearer.

Dyer.—A medium to large fall apple of good quality. Flavor sprightly, pleasant, very good for dessert purposes. Tree spreading, moderately vigorous, usually quite productive.

Early Joe.—A fine dessert apple ripening in late August and early September. Pale yellow shaded and striped with red and dotted with greenish spots.

Fameuse Sucre.—Fruit, medium, roundish oblate; color, dark red; flavor, sweet, pleasant; quality, very good. This variety has the white tender flesh of the Snow or Fameuse. October.

Fanny.—A very handsome dessert fruit, ripening in September. Size, medium, roundish oblate, tapering a little towards the eye; color, pale yellow, almost entirely overlaid with light red. Quality very good.

Flushing.—A very attractive apple of the Spitzenburg type. Tree upright, spreading: slow in coming into bearing and thus far only moderately productive. Fruit, roundish conical, light yellow well covered with red and dotted with many large fawn-colored dots: flavor, mild, almost sweet; texture, juicy, crisp, tender; quality, very good.

Gideon.—Tree upright, slightly spreading, vigorous and productive. Fruit, medium to large, roundish, slightly conical; color, clear light yellow, occasionally with a light red cheek; flavor, brisk, sub-acid. Desirable for culinary purposes. Tree resembles Duchess in habit of growth. September and early October.

Gloege.—A yellow, roundish, conical apple with a peculiar sub-acid flavor. An abundant bearer, but the fruit is not attractive enough for market and is almost too poor in quality for home use.

Golden Russet.—A fine winter russet; grows well and bears well here. Tree a spreading, vigorous grower. Desirable for home use.

Hawley.—A very large, tender apple of good quality. Subject to water core. Not very desirable here.

Iowa Keeper.—Tree upright, vigorous and quite productive. Fruit, red-cheeked, hard-fleshed, of medium size and fair quality. Keeps in perfect condition for some time after other varieties are gone in the spring.

Jefferis.—A fine early dessert apple ripening in September. Size, medium, roundish, oblate; color, yellow, striped with dark, rich red; quality, best. Valuable for home planting.

Kinnaird.—Tree is a spreading grower, with roundish head. Fruit, large, roundish, oblate; color, yellow, well shaded with dark red; flavor, mild, rich, aromatic; quality, good. December to March.

Longfield.—Size, medium, roundish, conical; color, pale yellow, with a brownish-red cheek, slightly russeted. Flavor, sub-acid, sprightly. Tree a spreading, moderately vigorous grower and a very heavy bearer. September to October.

Louise.—A Canadian apple supposed to be a Snow seedling. Size about medium, roundish; color greenish-white with reddish-brown cheek; quality very good; flesh white and tender, like that of Snow. November to January.

Magog.—An attractive yellow, red striped apple of fair to good quality. Eleven year old trees are unproductive as yet and the variety does not seem likely to prove very valuable. November to March.

Morris Red.—Tree a good grower, but rather slow in coming into bearing. Fruit medium to large, of firm texture, attractive appearance and good quality. November to February.

Nansemond.—A medium to large, showy, red, winter apple of good quality. Has fruited sparingly as yet and requires further trial. November to March.

Northfield.—Large, red, very handsome. Good for culinary purposes. Not productive enough for market. September to December.

Oakland.—Tree a spreading, rather slow grower and not a very sure bearer. Fruit medium in size, oblate; color dark red; quality very good. November to March.

Peter.—A dark red apple ripening in September and keeping for several weeks. A seedling of Wealthy and practically identical with that variety.

Quince.—A very large, yellowish apple often a little irregular in shape. Fairly good for culinary purposes. August.

Rambo.—An old, well-known late fall and early winter variety. Fruit roundish oblate; color light yellow, streaked and marbled with dull red in the sun, sprinkled with large dots. Texture tender, fine grained; flavor mild, sub-acid, very pleasant. Desirable for home use. October to December.

Red Dettmer.—A Russian variety ripening in September. Size large, roundish, oblate, slightly conical; color pale yellow, washed and splashed with light and dark red: flavor brisk sub-acid. Tree a vigorous, upright, slightly spreading grower inclined to be unproductive.

Red June.—A small, red apple of good quality, ripening in early August. Tree vigorous, upright and quite productive here.

Ribston.—An English variety of high standing in the country from which it comes. Size medium, roundish; color yellow, clouded with dull red on the sunny side; flavor sub-acid, rich, aromatic. Unproductive here. November to April.

Ronk.—Tree upright, spreading, rather slow to come into bearing. Fruit medium to large, roundish oblate; color greenish yellow, with a brownish-red cheek. Quality good. October to December.

Rosenhager.—A good grower and an abundant bearer. Fruit very large, brownish-red, of fair quality only. Ripens in October and keeps but a short time. Origin Russia.

Roxbury.—A large, roundish, oblate, russet apple of good quality. Valuable for home and market. January to June.

Sheriff.—A spreading, vigorous grower, usually quite productive. Fruit medium in size, roundish; color greenish, with dull red cheek; quality good. November to March. Promising for market.

Tolman.—One of the best winter sweet apples, but frequently inclined to be a little tough and corky. Fruit roundish-oblate, pale yellow, frequently with a blush on the exposed side. The tree is a good strong grower. October to March.

Titovka.—A very large, beautifully colored apple ripening in August and keeping until the middle of September. The tree is rather a poor grower and doubtless the variety would succeed best top-worked on some strong-growing kind. Possesses the characteristics of a good market variety and would seem desirable to follow Duchess.

Water.—Tree upright, rather dwarfish, bears every other year. Fruit roundish-ovate, yellow, shaded with dark red, of fair quality only. Does not appear very desirable. November and December.

VARIETIES FOR HOME USE AND MARKET.

Bailey Sweet.—A very large, showy, red winter apple of sweet pleasant flavor. Tree moderately vigorous and productive. When a sweet apple is desired this variety should take well because of its large size and attractive appearance. November to March.

Bough.—Not valuable for market purposes, but one of the finest early sweet apples for home use. Fruit roundish-conical, clear pale yellow, of best quality. The tree is vigorous and ordinarily productive. July and August.

Garden Royal.—Unsurpassed in quality and particularly desirable for the home orchard. Fruit roundish-oblate, greenish-yellow, striped and splashed with rich red, very tender, rich, mild, aromatic. Tree upright, moderately vigorous. September.

Grimes.—A roundish-oblate, yellow, smooth-skinned apple of very good quality. The tree is a fairly vigorous grower and a profuse bearer. A good dessert and market variety. November to March.

Hubbardston.—Fruit roundish, inclining to conical; color yellow, mostly overspread and indistinctly striped with red patches and tracings of yellow russet; texture crisp, tender; flavor rich, mild; quality very good. Tree a good grower and an abundant bearer. Quite free from scab. A profitable market variety and deserving of a place in every home orchard. November to February.

Jonathan.—Size medium, roundish-conical; color clear, light yellow, beautifully shaded with rich dark red; quality best. Valuable for dessert and market purposes. One of the most productive, regular bearers in the Station collection. November to March.

TABULATION OF APPLES, 1901.

ABBREVIATIONS: Month—e, early; m, middle; l, late. Form—c, conical; i, irregular; o, oblate; ob, oblong; ov, ovate; r, roundish. Color—g, green; r, red; ru, russet; w, white; y, yellow. Texture—c, crisp; d, dry; f, firm; j, juicy; t, tender. Flavor—a, acid; m, mild; s, sweet. Use—d, dessert; k, kitchen; m, market.

Name.	Planted.	Vigor.	Bloom.	Productiveness.	Season.	Weight in ounces.	Form.	Color.	Texture.	Flavor.	Quality.	Use.
Arnold	1890	9	May 18	5	Nov., Mar.	5.5	o	y r	t c	m	7	m d
Babbitt	1890	4	" 16	4	Oct., Dec.	3.6	o	y r	f c	a	7	m
Bailey	1888	7	" 16	5	Nov., Mar.	5.4	r ob	r	t	s	8	d m
Battullen	1888	10	" 16	1	Nov., Mar.	3.6	r o	y r	t	a	7	......
Ben Davis	1893	10	....	1	Dec., May.	4.6	r c	y r	f d	m	4	m
Bishop Bourne	1895	8	May 10	1	Oct.	3.9	r c	y r	c j	s	5	......
Black Lady	1888	7	" 10	10	Oct., Mar.	.5	r o	r	t c	m	6	d
Bottle Greening	1890	18	" 18	1	Nov., Mar.	3.4	r o c	g y	t c j	a	8	m d
Bough	1888	9	" 18	1	Aug.	3.5	r c	y	t	s	9	d k
Bradford	1890	8	" 18	6	Dec., Mar.	2.6	r ob	y r	t c	m	4	m
Buckingham	1892	10	" 18	6	Nov., Feb.	5.9	c o	g y r	t j	m	8	d m
Canada Baldwin	1890	10	" 16	2	Dec., Apr.	2.8	r o	y r	t c	m	7	d m
Chenango	1888	10	" 18	6	Aug., Sept.	4.6	ob c	y r	t	a	8	d m
Cogswell	1888	9	" 13	8	Oct., Mar.	5.5	o c	y r	t c	m	5	d m
Colton	1888	9	" 10	6	Aug.	4.2	ov c	g y	t j	m	7	d m
Cornell	1890	8	" 18	4	Sept.	3.5	r c	y r	t	m	7	d
Cullin	1890	8	" 18	1	Jan., Apr.	2.8	r ob	g y	f	m	6	d m
Dickinson	1889	8	" 18	5	Nov., Apr.	3.6	r c	y r	t	a	5	m
Dyer	1888	8	" 14	9	Sept., Oct.	5.1	r	y	t	m	9	d
Early Joe	1892	7	" 20	10	Aug., Sept.	2.5	r o c	y r	t	a	9	d
Fameuse Sucre	1890	8	" 14	3	Oct.	4.4	r o	r	t	m	9	d
Family	1890	10	" 16	2	Nov., Mar.	2.5	o	g y r	f	m	6	m
Fanny	1890	10	" 18	3	Aug., Sept.	4.4	r o	y r	t	m	9	d
Flushing	1888	8	" 16	2	Nov., Feb.	3.5	r c	y r	f c	m	7	d m
Garden Royal	1888	5	" 18	3	Aug., Sept.	2.8	r o	y r	t	m	10	d
Gideon	1890	10	" 16	4	Sept.	4.4	r c	y r	f c	a	6	k m
Gloege	1888	9	" 14	4	Nov., Apr.	6.8	c	y r	f	m	5	m
Golden Russet	1888	10	" 11	5	Dec., Apr.	3.6	r o	y ru	f	m	7	d m
Grimes	1890	8	" 18	4	Nov., Mar.	2.4	r o	y	f c	m	8	d m
Hagenkopt	1888	10	" 20	2	Sept	5.2	r c	y r	f	a	5	m
Hargrove	1892	10	" 16	1	Nov., Mar.	4	r c	y r	f	m	5	......
Hawley	1888	10	" 13	8	Aug., Sept.	7.8	r o	y	t j	a	8	d
Hubbardston	1888	10	" 13	7	Nov., Feb.	6.7	r c	y r	t c	m	9	d m
Indian	1892	10	" 20	4	Nov., Apr.	3.2	r o c	y r	c	m	4	m
Iowa Keeper	1891	10	" 18	2	Dec., June.	2.8	r o	g y r	f	m	7	d k
Jefferis	1888	8	" 18	4	Sept.	3.2	r o c	y r	c t j	m	10	d
Jersey Sweet	1888	9	" 16	10	Aug., Sept.	5	r	y r	t	s	8	d k
Jonathan	1888	8	" 18	10	Nov., Mar.	3.9	r c	y r	c j	a	10	d m
Keswick	1888	6	" 16	10	Aug., Sept.	3.4	r ov	y	c	a	5	k
Kinnaird	1892	10	" 18	2	Nov., Mar.	5.4	r oc	y r	t j c	m	7	m
Lankford	1892	10	" 18	2	Nov.	3.8	o c	g w r	f	a	5	......
Longfield	1892	9	" 10	7	Sept., Oct.	2.8	r c	y r	c t	a	5	k m
Louise	1890	10	" 16	5	Nov., Jan.	4.4	r	y r	t c	m	8	d m
Lowell	1890	8	" 20	8	Aug., Sept.	3.5	ob	y	t j	m	8	d m
Magog	1890	8	" 18	1	Nov., Mar.	4.3	r ob	y r	t c	m	5	m
Mason Orange	1890	9	" 20	1	Nov., Jan.	3.7	r ob	y r	t j	m	9	d m
Minkler	1892	8	" 11	6	Jan., Mar.	3.6	r c	y r	f	m	6	m
Morris Red	1890	8	" 18	2	Nov., Feb.	4.6	r ob c	y r	t j c	m	8	d m
Nansemond	1892	8	" 18	1	Nov., Feb.	2.6	r o	y r	c t	m	6	d m
Oakland	1888	8	" 13	4	Nov., Mar.	4.1	r o	y r	t	m	8	d m

APPLES.—CONCLUDED.

Name.	Planted.	Vigor.	Bloom.	Productiveness.	Season.	Weight in ounces.	Form.	Color.	Texture.	Flavor.	Quality.	Use.
Oldenburg	1892	8	May 16	8	Aug., Sept.	4.1	o	y r	c	a	5	k m
Ontario	1890	9	“ 16	8	Nov., Mar.	3.1	r o	y r	t c	a	7	d m
Peck	1888	9	“ 18	1	Nov., Mar.	3	r	g y r	t c j	m	9	d
Peter	1890	8	“ 13	8	Sept., Oct.	3.1	o c	g y r	t j	a	5	k m
Picket	1888	8	“ 20	1	Nov., Feb.	3.3	r o	y r	f c j	m	7	d
Pine Stump	1892	8	“ 14	2	Nov., Mar.	2.4	r	y r	t c	m	6	d
Primate	1888	10	“ 11	7	Aug.	3.9	r c	y r	t	m	9	d m
Rambo	1890	10	“ 18	3	Oct., Dec.	2.8	r o	y r	t	m	8	d
Red Astrachan	1888	10	“ 13	5	Aug.	3.3	r o	g r y	c	a	6	d k m
Red Canada	1888	6	“ 18	2	Nov., Mar.	3.6	o	y r	c t	m	9	d m
Red Dettmer	1888	10	“ 13	5	Sept., Oct.	5.4	r o	y r	c t	a	6	k
Red June	1892	10	“ 18	10	Aug.	2.7	ov r	r	f	a	8	d m
Ribston	1888	8	“ 10	5	Nov., Apr.	4.6	r c	y r	f c j	m	7	m d
Ronk	1888	8	“ 13	3	Dec., Mar.	4.2	r o	g y r	t c	a	7	......
Rosenhager	1888	10	“ 16	10	Sept., Oct.	6.7	r o c	r	t	a	5	m
Roxbury	1890	9	“ 11	6	Jan., June.	3.8	r o	y r u	f	m	7	m d
Shannon	1893	8	“ 16	1	Dec., Mar.	4.8	r o c	g y r	t c	m	7	m
Sheriff	1891	9	“ 16	5	Nov., Mar.	5.2	r o c	g y r	t c	m	7	m
Shiawassee	1898	9	“ 18	1	Oct., Jan.	4.6	r o	y r	t c	m	8	d
Sikuli	1894	7	“ 16	1	Dec., Apr.	4.8	r o	g y r	f c	m	6	......
Stark	1888	10	“ 16	7	Dec., May.	4.6	r o v	g y r	t j	m	7	m
Stuart	1890	10	“ 18	1	Nov., Feb.	2.8	r o	y	c f j	a	6	m d k
Summer Lievland	1890	10	“ 10	7	Aug.	3.9	r o	g y r	t	m	7	d
Summer Pearmain	1888	10	“ 18	1	Sept.	3.1	ob c	y r	t	m	10	d
Tolman	1888	10	“ 18	8	Nov., Mar.	3.1	r o	y	f	s	7	d m
Titovka	1888	7	“ 11	10	Aug., Sept.	5.9	ob c	g y r	t c	a	6	k m
Wagener	1893	7	“ 13	1	Nov., Mar.	5.1	r o	y r	t c	m	8	d m
Water	1890	8	“ 18	5	Oct., Dec.	2.4	r o v c	w r	t	m	5	d m
Wealthy	1890	8	“ 13	10	Sept., Oct.	4	o c	y r	t	a	6	k m
Yellow Transparent	1888	8	“ 16	2	Aug.	5.3	r c	y	t	a	5	k m
York Imperial	1892	9	“ 20	1	Nov., Feb.	3.9	o i	y r	f c	m	8	d m

Keswick.—One of the best early cooking apples. Cooks well when fruit is not more than half grown. Fruit roundish-ovate, clear greenish-yellow, crisp and juicy. Tree upright, spreading, very productive.

Oldenburg (Duchess).—The most profitable late summer and early fall market apple grown. Fruit oblate, pale yellow, washed and striped with red. The tree is a good grower and a very abundant bearer.

Ontario.—A cross between Spy and Wagener and one of the most promising of the newer winter varieties. Size large, oblate, inclining to conic; color whitish-yellow with a red cheek; texture tender; flavor brisk, sub-acid; quality very good. Station trees bore half a crop in 1896, at six years of age, and during the five years following have produced full or nearly full crops each season. November to April.

Primate.—Tree vigorous, round-headed, productive. Fruit roundish-oblate, inclined to conical; color greenish-yellow, occasionally with a faint blush; flesh tender, juicy, fine-grained; flavor, rich, sub-acid; quality very good. Particularly desirable for home use. August and September.

Shiawassee.—Very similar to Snow except in shape, being somewhat flattened. Tree upright, spreading, vigorous and quite productive. Superior to the Snow apple. October to January.

Stark.—A large, greenish-yellow apple with a brownish-red cheek. The tree is a very vigorous grower and an abundant bearer. A desirable market variety. December to May.

Summer Pearmain.—A valuable dessert apple ripening in September. Size medium, oblong, slightly conical; color yellow, shaded and streaked with red; quality best. The tree is vigorous and bears young.

Wagener.—A medium sized, handsomely colored apple of very good quality. Valuable as a filler in commercial orchards, also valuable for permanent planting for home and market purposes. The tree matures young, bears heavily and is short lived.

Wealthy.—Tree moderately vigorous, with a roundish head; an early and abundant bearer. Fruit large, roundish-oblate; color pale yellow, mostly overspread with dark red. A valuable fall market variety. Will keep until December or later with proper handling.

Yellow Transparent.—An early Russian variety valuable for home planting. Size medium, roundish, remotely conical; color clear, light yellow; texture tender, juicy; quality good. August.

CRAB APPLES.

August.—Tree vigorous with roundish head. Fruit roundish-conical, very large for a crab apple; color yellow, washed and striped with red; texture crisp, tender; quality fair. Not considered valuable.

Excelsior.—Above medium in size, handsomely colored, of good quality. Should take well in market but it is a trifle tender and requires careful handling. Tree is an upright, vigorous grower and an abundant bearer.

Florence.—Received from Stark Bros. Fruit small, oblate; color clear yellow, striped with light red, quality good. Tree is an upright, spreading grower of moderate vigor. Inclined to overbear and much of the fruit is undersized and imperfect as a result of this tendency.

Gibb.—Small, roundish-oblate, pale yellow, of poor quality. Worthless here. August.

Jelly.—Tree tall, upright, spreading, vigorous. Fruit roundish; color pale yellow, overlaid with bright red; flesh white, crisp and juicy; quality good. Rather slow to bear, but otherwise promising. September and early October.

TABULATION OF CRAB APPLES, 1901.

ABBREVIATIONS: Same as for apples.
(Pyrus baccata; including actual and supposed hybrids.)

Name.	Planted.	Vigor.	Bloom.	Product.	Season.	Weight in ounces.	Form.	Color.	Texture.	Flavor.	Quality.	Use.
August	1890	8	May 10	5	Aug., Sept.	2.3	r c	y r	c t	a	4	k
Dartmouth	1890	10	" 10	10	September	1.5	r	r	c	a	9	km
Excelsior	1890	9	" 18	10	Aug., Sept.	2.4	r o	y r	t	a	6	km
Florence	1890	8	" 10	5	September	1.1	o	y r w	tc	a	6	k
Gibb	1890	8	" 10	10	August	1.2	o	y	c	a	2	
Jelly	1890	10	" 13	8	Sept., Oct.	.1	r	y r	cj	a	6	km
Martha	1890	8	" 18	6	September	.9	o	y r	t	m	7	km
No. 1 New	1890	10	" 13	10	August	5	r	g y r	ct	a	7	km
October	1890	8	" 16	6	Aug., Sept.	2.7	r	r	ctj	a	4	
Quaker	1891	10	" 16	5	Oct., Dec.	1.5	r ob	y r	c	m	3	
Serotina	1899	2	" 13	10	1September	.5	r ob	r	c	a		
Whitney	1890	10	" 10	10	August	2.4	r	y r	c	a	8	km

Martha.—Fruit medium, oblate; color yellow well overspread with bright red; quality very good. Tree upright, spreading, vigorous, moderately productive. Late August and early September.

No. 1 New.—Received from the late Peter M. Gideon of Excelsior, Minnesota. Although a crab seedling, its appearance would place this variety with the apples rather than with the crabs. Resembles Duchess closely in tree and somewhat in fruit. Ripens about a week later than Duchess, and would seem to be a valuable variety to follow it for market. Very good for culinary purposes, but too brisk for eating uncooked. A trifle tender and should be handled carefully.

October.—Small, yellow, shaded with red, of poor quality. Subject to dark leathery spots beneath the skin. Worthless here.

Quaker.—A handsome, upright, spreading grower, but a shy bearer. Fruit yellow with brownish-red cheek. October to November.

Serotina.—Fruit roundish-oblate, small, about the size of a Richmond cherry; color bright red. Tree dwarfish, very productive. Of no value except as a novelty.

VARIETIES FOR HOME USE AND MARKET.

Dartmouth.—Size medium, oblate; color bright dark red; texture crisp; quality very good. Tree is upright, spreading, vigorous. Late August and early September.

Whitney.—Medium to large, smooth and perfect in form; color dark red on yellowish ground, handsome; texture crisp; flavor mild, sprightly, sub-acid; quality very good. Tree is an upright, vigorous grower and an abundant bearer.

NUTS.

One American, three European, and four Japanese chestnuts fruited this season. Paragon, one of the European group, was the most productive. It is the most promising variety on trial. Cosford and Kentish Cob filberts fruited sparsely. They are valuable plants for ornamental purposes and can be expected to produce some fruit under favorable conditions. The Japan walnut, Juglans Seiboldii, continues to grow thriftily and again bore, as for several years past, a full crop of nuts. Pecan seedlings from Iowa, planted in 1890, have grown vigorously but have not yet fruited. Three-year-old hard-shelled almonds are making a strong healthy growth. Last spring they showed a few blossoms, but set no fruit. English walnuts, a number of varieties of which are upon trial, still continue to grow very slowly and show no signs of fruiting.

CHESTNUTS—AMERICAN GROUP.

Hathaway.—A seedling of the native sweet chestnut, from the late B. Hathaway of Little Prairie Ronde, Mich. A tree planted in 1890 fruited for the first time this season. The nuts do not appear very different from the common, sweet chestnut. They are of medium size and very good quality. The tree is a moderately vigorous grower with roundish head.

CHESTNUTS—EUROPEAN GROUP.

Comfort.—Received from Wm. Parry, Parry, N. J., in 1894. The tree is a good grower but apparently a very shy bearer. The nuts are of large size and good quality and are borne in large thick burs.

Numbo.—The poorest grower among the European chestnuts on trial. A nine year old tree stands less than five feet in height and has a poor, unshapely top. The nuts are very large and quite sweet. Ripens quite early.

Paragon.—The most promising chestnut on trial. A good grower and an early, regular, very abundant bearer. A seven year old tree has borne four crops in succession of large sound nuts of good quality. When in fruiting the tree presents a very attractive appearance. The nuts are nearly equal to the native sweet chestnut in quality. This variety should be tried by all who contemplate planting chestnut trees.

CHESTNUTS—JAPANESE GROUP.

Hale.—Received from J. H. Hale, South Glastonbury, Conn., in 1899. Although planted but two years, this variety bore a full crop this season, thus exhibiting the early bearing tendency characteristic of this group. The nuts are large and attractive in appearance and are borne in round thin burs. In quality they are sweet and quite good, although inclined to be a trifle dry and starchy. One of the most promising of the Japanese varieties on trial.

Japan Giant.—Planted in 1896. A moderately vigorous grower with a compact roundish head; rather unproductive as yet. The nuts are of very large size, at least a half larger than Paragon. Quality poor, inclined to be a little bitter. Burs large, round, thin, containing from two to three nuts.

Japan Improved.—A slow grower and usually rather unproductive, although this season the variety bore nearly a full crop. The nuts are of very large size, rather light color, and of good quality. The burs which are round and thin usually contain either one or two nuts. Not very promising.

Reliance.—Although set but two years, this variety bore nearly a full crop this season. The tree has grown very slowly which may perhaps be attributed to its early bearing tendency. The nuts are of medium size and fair quality. Requires further trial.

FILBERTS.

Cosford.—Received from the Division of Pomology, Washington, D. C., in 1895. A hardy variety more sure to bear than Kentish Cob. The nuts are above medium in size, elongated, smooth, attractive and very thin-shelled. The plants are a little less thrifty in growth than Kentish Cob.

Kentish Cob.—The bush is a very strong grower with large thick leaves. No fruit this season, but last year the plants bore about three quarts of nuts each. The nuts are very large, at least a half larger than Cosford, elongated, of good quality. Planted in 1892.

PECANS.

In 1890, two pecan seedlings from Iowa were planted on the Station grounds. The trees have grown thriftily and have attained a height of about twenty-five feet and are from six to eight inches in diameter, they have not yet fruited, but indications point to their bearing when they have attained a little greater age. Last spring one of the trees blossomed but failed to set fruit.

ALMONDS.

Two trees of Snelling almond, a soft-shelled variety, were planted in 1892. They grew well and bore some fruit, but were killed by the hard freeze of 1899. Three years ago, two trees of a hard-shelled variety were set out. They had grown very vigorously. Last spring they showed a few blossoms but did not set any fruit.

WALNUTS.

Japan Walnut (Juglans Sieboldii).—This variety never fails to bear a full crop of nuts. The tree is a rapid thrifty grower, quite attractive in appearance, hardy and valuable for ornamental purposes. The nuts are a little smaller than the English Walnut which they resemble in shape. The flavor somewhat resembles that of the native butternut.

English Walnuts.—English, or Persian, walnuts are a failure here. The trees grow very slowly and give no indication of fruiting. One tree, eleven years old, measures less than five feet in height.

WATERMELONS.

Last spring seeds of eighty-seven varieties of watermelons, all under numbers, were received for trial from the Department of Agriculture, Washington, D. C. Quite a large proportion of these new varieties came from Russia and other European countries. The seed was planted May 29, in sandy loam well enriched with wood ashes and stable manure. With few exceptions the seeds germinated and the plants grew thriftily. The first melons ripened about the fifteenth of August. A few of the later kinds failed to mature before the close of the season. Nearly all varieties bore small melons and the quality in most instances was not very good. A number of kinds had light colored flesh varying from creamy white to orange yellow. A few varieties proved to be winter kinds. The latter were all of small size and had hard gourd-like shells. The quality of most of the later ripening kinds was no doubt much impaired by cold wet weather which occurred in September.

South Haven, Mich., October 10, 1901.

STRAWBERRY NOTES FOR 1901.

BY L. R. TAFT AND M. L. DEAN.

Bulletin No. 195.—Horticultural Department.

STRAWBERRIES, 1901.

ABBREVIATIONS: Form—b, broad; c, conic; d, depressed; i, irregular: n, necked; o, oval; l, long; r, round; ob, oblong. Size—l, large; m, medium; s, small. Sex—p, pistillate or imperfect; b, bisexual or perfect. Color—b, bright; c, crimson; d, dark; l, light; r, red; s, scarlet.

Varieties.	Sex.	Date.			Vigor.	Hardiness.	Per cent of bloom killed by frost.	Productiveness.	Size.	Form.	Color.	Quality.	Firmness.
		Bloom	First ripe.	Last ripe.									
Alpine Seedling....	b	May 15	Failed to mature	any fruit.									
Anlo................	p	" 12	June 17	July 4	90	90	5	70	l	b c	b s	75	80
Anna Kennedy.....	p	" 6	" 15	" 5	80	85	4	85	m	r c	b r	75	75
Arkansas Traveler.	b	" 5	" 15	" 5	85	95	5	63	m	r c	c	65	70
Armstrong	b	" 16	" 18	" 5	90	75	5	80	l	b c n	b r	90	75
Arnout	b	" 5	" 18	" 7	98	90	4	88	s m	l r c	b s	90	90
Arrow	p	" 16	" 16	" 5	50	60	3	70	v s	r c	b s	80	88
Avery	p	" 8	" 16	" 6	95	98	2	90	l	r c	b s	85	98
Beder Wood.........	b	" 13	" 16	" 7	100	100	2	95	m l	r c	s	90	91
Bennett	p	" 13	" 15	" 9	100	95	2	80	m l	o b c	b c	89	95
Berry.......	p	" 13	" 16	" 7	75	80	2	96	l	b c	b r	80	85
Bethel..............	p	" 21	" 12	" 4	90	85	4	85	l	r o	s	89	90
Bisel	b	" 10	" 5	" 1	80	85	2	90	m	b c	b r	85	80
Bismarck...........	b	" 16	" 17	" 4	25	25	1	75	s	r c	d r	80	85
Blonde	b	" 17	" 15	" 6	98	100	1	95	l	r c n	b l r	75	80
Bobolink	b	" 5	" 12	" 3	75	90	3	100	l	i r c	l c	75	60
Bostonian	b	" 17	" 16	" 8	100	100	2	100	m	b c	b r	80	75
Brandywine	b	" 12	" 10	" 7	80	95	2	90	m l	r c	s	98	95
Brownie	b	" 10	" 14	" 10	100	100	4	95	m	r c	l r	90	90
Bryan	b	" 13	" 13	" 6	75	25	2	80	m l	o c r	d c	85	85
Bryant	b	" 25	" 24	" 7	90	100	3	95	m	r c n	s	90	90
Bubach..............	p	" 25	" 14	" 7	90	100	3	95	m	r c n	s	90	90
Burnett..............	b	" 27	" 20	" 6	50	60	2	83	m	l c n	l r	90	75
Bush Cluster.......	b	" 8	" 14	" 6	98	98	3	75	l	i r c	l r	75	80
Carmi Beauty......	p	" 8	" 16	" 3	100	100	3	90	l	r c	l r	80	75
Carrie Silvers......	b	" 11	" 12	" 5	95	40	2	100	m l	r c n	d c	90	95
Champion	b	" 9	" 17	" 4	60	60	2	78	s m	r c	d r	75	80
Chenango	b	" 7	" 6	" 6	75	90	1	85	l	r c	c	85	75
Cherokee...........	p	" 12	" 17	" 5	70	75	4	75	l m	i r c	s	90	85
Clyde................	b	" 9	" 8	" 2	100	100	4	100	l	r c	s	90	90
Columbus	b	" 13	" 18	" 5	78	90	3	78	m l	i b c	d r	85	80
Crescent	p	" 4	" 12	" 2	90	95	2	90	s m	r c	d s	80	95
Crockett.............	b	" 6	" 15	" 6	100	100	1	98	m	ob c	l c	70	98
Darling..............	b	" 5	" 15	" 5	95	100	2	50	m	r c	b s	70	70
Dakota	b	" 5	" 13	" 8	80	80	2	80	m l	i l c	c	75	75
Dictator.............	p	" 6	" 13	" 7	85	90	1	92	m l	r c	b r	85	80
Dole	p	" 15	" 11	June 31	95	100	....	96	m l	r o c	l c	89	90
Dollar	p	" 11	" 10	July 1	40	55	1	75	m	r b c	b c	75	70
Downing's Bride...	p	" 16	" 15	" 6	98	100	....	75	s m	r ob c	d c	90	90
Drouth King.......	p	" 4	" 14	" 6	100	98	1	90	m l	b c	d c	90	85
Dunlap	b	" 14	" 17	" 7	95	100	2	85	s m	i o c n	b c	78	92
Early Bird..........	b	" 11	" 16	June 30	45	40	4	75	s m	i o b c	b r	80	85
Early Jack..........	b	" 5	" 14	July 2	80	90	4	80	s m	r c	l r	89	75
Eleanor..............	b	" 6	" 15	" 3	75	80	3	75	m	r c	l r	80	75
Emperor.............	b	" 13	" 13	" 6	95	98	3	90	m l	i o b c	d c	85	95
Empress.............	b	" 11	" 8	" 1	99	100	1	80	m l	r o b c	d c	90	95
Enhance	b	" 12	" 8	" 8	90	95	3	98	m	r c	b c	90	85
Epping	p	" 9	" 16	" 4	90	90	7	85	l	r c	c	75	70
Equinox.............	b	" 7	" 14	" 3	80	90	1	90	m l	i r c	l c	85	80
Evans	b	" 8	" 15	" 3	90	90	2	85	l	r c	b l s	75	80

STRAWBERRIES—CONTINUED.

Varieties.	Sex.	Date.			Vigor.	Hardiness.	Per cent of bloom killed by frost.	Productiveness.	Size.	Form.	Color.	Quality.	Firmness.
		Bloom.	First ripe.	Last ripe.									
Excelsior	b	May 3	June 13	July 1	100	100	5	90	m	r c	b c	95	90
Flash	b	“ 11	“ 8	“ 6	100	100	8	75	l	b c	b s	85	80
Fountain	b	“ 8	“ 15	“ 4	100	100	3	95	l	r c	b s	75	70
Fremont	b	“ 14	“ 17	“ 8	100	100	3	80	l	r c l	s	75	70
Gandy	b	“ 16	“ 10	“ 8	95	98	1	100	l	r c	l c	90	85
Garringer	b	“ 17	“ 15	“ 2	80	90	....	80	l	i c	b s	75	70
Gen. Fifer	b	“ 12	“ 10	“ 10	90	95	1	80	m l	i r c	d r	60	75
George's Triumph	p	“ 17	“ 17	“ 10	98	100	....	100	m l	ro b c	l c	90	90
Gertrude	b	“ 7	“ 18	“ 6	90	90	4	95	m	r c n	b c	65	70
Giant	b	“ 5	“ 14	“ 6	90	95	4	75	l	r c	b s	70	65
Gibson	b	“ 13	“ 17	“ 6	92	85	....	98	m l	†	c	75	70
Gladstone	b	“ 14	“ 1	“ 9	85	75	....	95	v l	ir rc	l s	90	98
Glen Mary	b	“ 10	“ 17	“ 7	100	100	1	100	l	b c	b c	80	100
Greenville	p	“ 12	“ 15	“ 9	80	90	1	95	l	r c d	d r	95	85
Haverland	p	“ 6	“ 12	“ 8	100	100	4	98	m l	r c	s	90	85
Heffin No. 3	p	“ 4	“ 15	“ 5	95	100	4	95	l	r c	b c	88	85
Hersey	b	“ 8	“ 16	“ 7	85	85	2	75	m	l c m	b r	70	65
Holland	p	“ 13	“ 10	“ 1	95	98	....	70	m	o c	d c	55	75
Homestead	b	“ 21	“ 19	“ 8	98	100	...	90	m l	r c	c	70	65
Hood River	b	“ 15	“ 7	“ 1	80	85	1	90	m l	r c	s	65	88
Hoosier	b	“ 20	“ 16	“ 5	50	75	....	92	m	r c	b c	70	65
Hovey		Did not blossom.											
Hull No. 3	b	May 17	June 15	“ 6	100	100	2	95	m l	r c	l r	85	75
Hunn	p	“ 27	“ 20	“ 9	80	90	....	85	l	b c	b s	75	85
Ideal	b	“ 17	“ 17	“ 3	85	85	....	50	l	b c	c	60	75
Ima	p	“ 6	“ 17	“ 10	95	95	4	60	m	r c	b s	70	75
Jarbola	p	“ 3	“ 14	“ 3	98	95	8	88	m l	l r c	b r	80	85
Joe	b	“ 17	“ 15	“ 4	100	100	1	85	l	ob r c	b c	85	95
Kansas	b	“ 17	“ 16	“ 9	100	100	1	100	s m	i r c	l c	75	90
King Worthy	b	“ 14	“ 12	“ 2	85	90	....	95	l	i r c	b s	80	75
Klondike	b	“ 15	“ 17	“ 8	89	92	1	75	l	i r c	d c	90	85
Knight	b	“ 9	“ 17	“ 4	90	75	2	85	m	r c	c	85	88
Lady Franklin	p	“ 6	“ 16	“ 8	95	98	3	75	m	i b c	b s	75	70
Lady Thompson	p	“ 8	“ 10	“ 6	100	98	3	90	l	r c	d r	80	75
Lanah	b	“ 8	“ 17	“ 10	98	100	1	60	m l	r c	b r	95	85
Lehigh	p	“ 8	“ 12	“ 2	100	100	4	98	m	r c	c	85	88
Leroy	p	“ 8	“ 14	“ 7	95	85	3	90	m l	ro b o	s	88	85
Livingston	b	“ 10	“ 17	“ 7	100	100	2	100	s m	l c	d c	98	85
Lloyd	p	“ 15	“ 13	“ 8	98	85	1	85	m	r ob c	d c	75	90
Lovett	p	“ 7	“ 15	“ 6	100	100	3	98	m l	r c	b s	90	85
Magoon	b	“ 13	“ 16	“ 8	75	80	5	40	l	b i c	d c	70	65
Mammoth	b	“ 11	“ 10	“ 6	65	40	10	50	s	i l n c	d c	85	80
Margaret	b	“ 11	“ 11	“ 2	90	95	4	75	l	b c	v d s	80	75
Marston	p	“ 4	“ 16	“ 9	85	92	4	50	m	r c	d c	75	65
Marshall	b	“ 6	“ 11	“ 5	75	85	2	95	l	r c	d s	95	90
Mary	b	“ 8	“ 14	“ 8	95	98	....	92	l	i r n c	b c	90	95
Maximus	b	“ 14	“ 15	“ 6	90	85	....	50	l	l i c	d c	70	70
Mayflower	b	Apr. 30	“ 10	“ 1	100	98	6	85	m	l r c	d r	95	85
McKinley	p	May 7	“ 16	“ 6	85	80	2	85	m l	l c	d c	85	80
Meridian	p	“ 17	“ 17	“ 5	85	95	3	90	m l	i r c	s	80	85
Mexican	b	“ 8	“ 16	“ 6	100	75	....	80	l	r c	d c	98	85
Michigan	b	“ 15	“ 16	“ 7	85	85	1	50	l	i b c	b r	90	85
Milton	b	“ 19	“ 10	“ 1	75	85	....	75	m	l c	b r	75	70
Morgan Favorite	b	“ 8	“ 12	“ 10	100	98	2	92	l	l r c n	s	85	80
Mrs. McDowell	b	“ 10	“ 16	“ 10	100	100	1	95	m l	i o b c	l s	90	75
Nettie	p	“ 17	“ 15	“ 8	90	80	....	75	l v l	i o b c n	l r	95	80
New York	b	“ 12	“ 10	“ 7	100	100	2	85	m l	e r c n	d c	95	90
Nick Ohmer	b	“ 9	“ 10	“ 2	75	75	3	85	l	o c	d c	75	75
Noland	p	“ 8	“ 16	“ 2	90	80	3	89	m	n i c	s	73	75
Nina	b	“ 15	“ 18	“ 6	95	95	....	90	l	r c	s	70	82

STRAWBERRIES.—Concluded.

Varieties.	Sex.	Date.			Vigor.	Hardiness.	Per cent of bloom killed by frost.	Productiveness.	Size.	Form.	Color.	Quality.	Firmness.
		Bloom.	First Ripe.	Last Ripe.									
No Name	b	May 10	June 17	July 8	100	100	....	100	m l	i r c	s	78	85
No. 1000	p	“ 13	“ 16	“ 3	100	100	....	75	l	r c	d c	98	85
Omega	b	“ 6	“ 14	“ 2	75	10	1	75	m	r c	s	70	82
Orewiler	b	“ 8	“ 17	“ 8	100	95	3	90	l	o c	b r	75	65
Parker Earle	b	“ 9	“ 16	“ 13	90	95	2	100	l	l r c n	d r	75	85
Parker Earle Jr.	b	“ 6	“ 15	“ 8	75	75	2	85	m l	r c	d c	75	75
Parsons Beauty	b	“ 14	“ 12	“ 7	100	100	1	80	m l	i r o c	*	90	85
Patrick	p	“ 17	“ 16	“ 4	98	90	....	92	m l	r c	d r	70	75
Pennell	b	“ 16	“ 18	“ 8	100	100	....	75	m l	†	s	95	75
Phippen	b	“ 14	“ 16	“ 4	80	95	....	95	s m	r c	d s	65	90
Phœnix	b	“ 9	“ 16	“ 6	90	90	3	90	l	r c	c	75	75
Plow City	b	“ 6	“ 14	“ 3	95	80	4	89	l	r c	b s	88	75
Pocomoke	b	“ 10	“ 18	“ 7	98	100	2	80	m	i r l c	d c	92	95
Ponderosa	b	“ 10	“ 17	“ 8	98	85	2	80	m l	i r c	c	85	85
Portage	b	“ 12	“ 13	“ 7	95	90	1	85	l	l r c	b c	70	75
Pride of Cumberl'd	b	“ 10	“ 18	“ 4	95	95	....	90	l	r c	b c	75	85
Pride of Ohio	b	“ 9	“ 16	“ 5	92	90	2	85	m	b c	b c	75	70
Purdue	p	“ 7	“ 16	“ 7	95	98	4	98	l	i c	b c	75	75
Reba	p	“ 12	“ 18	“ 6	65	50	1	50	m	r c	d c	95	85
Repeater	b	“ 11	“ 12	“ 6	80	65	1	100	s	‡	c	65	95
Ridgeway	b	“ 20	“ 16	“ 8	100	98	....	90	m l	r c	b c	90	95
Rio	b	“ 11	“ 16	“ 4	95	95	2	95	m l	r c	b r	75	72
Robbie	b	“ 16	“ 19	“ 7	98	98	....	90	m	i r c	l c	85	90
Rough Rider	b	“ 21	“ 20	“ 5	95	98	....	85	m l	r l n c	l c	92	90
Ruby	p	“ 12	“ 18	“ 6	80	80	3	90	m l	r c	b c	85	80
Sample	p	“ 13	“ 15	“ 7	100	98	2	90	l	r c	d s	98	95
Satisfaction	b	“ 5	“ 15	“ 7	95	94	4	85	m	r c	b d c	85	80
Scriver	b	“ 5	“ 14	“ 7	85	80	3	65	m l	l n c	c	75	70
Seaford	p	“ 12	“ 18	“ 6	95	75	1	80	m	i r n c	d c	95	92
Seedling No. 1	b	“ 3	“ 15	“ 1	100	100	4	100	s m	r c	l s	85	80
Seek-no-further	b	“ 4	“ 13	“ 6	95	95	3	90	l	r c	b s	85	75
See No. 1	b	“ 4	“ 13	“ 5	90	90	3	80	m	r c	b d r	90	80
See No. 2	p	“ 10	“ 13	“ 3	95	98	2	98	l	r c	d b r	92	90
See No. 3	p	“ 15	“ 14	“ 8	98	95	2	95	l	i c	b r	75	75
See No. 4	p	“ 9	“ 16	“ 8	85	85	3	90	l	r c	b c	75	75
Seneca Chief	b	“ 9	“ 17	“ 7	70	75	4	65	m l	r c	d c	75	75
Shepherd	p	“ 21	“ 20	“ 11	98	100	1	97	m	i o b c	l c	70	95
Smith	b	“ 4	“ 14	“ 6	95	80	4	65	m	r c	b r	80	78
Snowball	b	“ 16	“ 10	“ 10	90	90	....	75	m l	r c	b s	80	75
Sparta	b	“ 7	“ 13	“ 3	89	95	4	85	l	b c	b r	75	80
Splendid	b	“ 5	“ 14	“ 6	94	85	6	85	m l	r c	d s	95	90
Staples	b	“ 12	“ 13	“ 4	92	78	1	80	s m	n r c	s	75	80
Star	b	“ 11	“ 17	“ 6	65	75	3	55	m l	b c	b s	75	70
Stella	p	“ 26	“ 22	“ 8	100	100	....	89	m l	§	l r	80	95
Stevenson	p	“ 6	“ 13	“ 5	75	75	4	50	m	r c	r b	75	70
Stone	p	“ 10	“ 14	“ 1	100	100	2	100	m	r c	b l r	75	70
Stone 130	b	“ 9	“ 17	“ 6	100	100	3	100	m l	r o c	l c	85	90
Success	b	“ 7	“ 15	“ 6	95	98	3	85	l	r c	d c	89	80
Sunnyside	p	“ 16	“ 19	“ 8	85	75	....	75	m	n r c	l r	80	85
Sunshine	p	“ 18	“ 18	“ 7	98	100	1	100	s m	n r c	l s	80	75
Timbrell	p	“ 9	“ 10	“ 10	100	98	1	85	l	r c	d c	75	70
Twilight	b	“ 12	“ 10	“ 6	100	100	....	95	m	r o c	d c	90	75
Up-to-date	b	“ 4	“ 10	“ 6	75	94	2	60	s	r c	l c	65	80
Vera	p	“ 6	“ 13	“ 8	75	95	3	45	m l	r c	b l r	85	75
Wetzel	b	“ 7	“ 15	“ 7	75	85	3	40	m	r c	b r	75	75
Whitney	b	“ 13	“ 17	“ 6	75	75	1	65	m l	r d	d c	85	80
William Belt	b	“ 13	“ 19	“ 4	95	98	....	98	l	b i c	b r	90	85
Woolverton	b	“ 21	“ 17	“ 6	85	85	....	75	m l	r c	b l c	80	75
Worlds Champion	p	“ 5	“ 11	“ 2	75	75	4	25	m l	b c	b r	70	70
1901	b	....	....	....	....	....	....	....	....	....	....	....	....

*Dull d r. † Flat o c. ‡ Reg. r c. § Fan shaped i o c.

A large number of recently-introduced varieties of strawberries that were planted in May, 1900, came into bearing this year and careful records were kept of their behavior. In the table, letters and figures have been used as symbols, and a key is placed at the head of the columns.

The "Notes on Varieties" give a somewhat detailed description of the plants and fruit, and points that might be of interest or value are touched upon. A "Summary," placed at the end of these notes, gives a short list of the more desirable kinds for various soils and seasons.

The trial plat which fruited in 1890 was cleaned out in July so that only one plant for each foot in the rows was left. From these runners were soon sent out, and what was practically a new plantation was secured. Notes upon some of the more valuable of these older varieties are also given.

NOTES ON NEW VARIETIES.

Alpine was sent out by the U. S. Department of Agriculture, Washington, D. C. Flowers perfect. Six plants were received November 24, 1900, and planted in the field. They were well covered with a coarse mulch and came through the winter in good shape. The plants appeared to be vigorous and healthy and threw out a few fruit stems, but failed to mature any fruit.

Bennett.—Received from W. F. Allen, Salisbury, Maryland. Flowers imperfect. The plants made a vigorous growth last season and came through the winter in good shape, appearing to be hardy. They developed a limited amount of bloom, for the vigor of the plants, but a small per cent of it was frosted. The berries are of medium size, oblong conical in form; color, bright crimson; flavor, rich and sub-acid. The quality is good, but the plants were hardly productive enough this season to warrant any special recommendation.

Bobolink.—Received from Myer & Son, Bridgeville, Del. Flowers perfect. Only three plants of this variety were received, and the first reason they appeared weak but this year's growth shows much more vigor. The foliage is dark, large and dense, but the plants showed a scarcity of fruit stems. The berries are large, rather coarse and irregular, but quite attractive. The color is rather too light a crimson and the pulp is soft. Flavor very pleasant. Further trial is necessary to determine the value of this variety.

Bryan.—From Flansburgh & Peirson, Leslie, Mich. Flowers perfect. The plants appeared to lack vigor and made a weak growth, throwing very few runners or fruit stems; berries are medium in size; a little oblate conical; color, bright crimson; quality and firmness, good. Plants lack in productiveness.

Bush Cluster.—From Harrison & Sons, Berlin, Md. Flowers perfect. The growth of the plants is all that could be desired; fruit stems, strong and upright; fruit, large; light red; slightly irregular, round conical; flavor, medium; texture, rather soft. Further trial will be necessary to establish their value, but they seem to lack in productiveness.

Carmi Beauty.—From W. F. Allen, Salisbury, Md. Flowers imperfect. A very promising variety. In vigor and hardiness it has few superiors. The fruit stems are numerous, upright, strong and well covered by the dense growth of foliage. The fruit is large, regular, conical, rather light in color. The quality is good.

Carrie Silvers.—From Slaymaker & Son, Dover, Del. Flowers perfect. Seems to lack vigor and hardiness, but was fairly productive. The plants made a weak growth but formed many fruit stems. The fruit is of high quality, dark crimson, regular, elongated, slightly necked; pulp firm. Further trial may show more vigor.

Crockett.—From Harrison & Sons, Berlin, Md. Blossoms perfect. Hardy, vigorous, productive. The fruit stems are numerous, upright and strong, but not individually overloaded. The berries are irregular, oblong conical, a little soft and below the standard in quality; runners numerous. Owing to its vigor and productiveness, the variety has some promising points for an early sort.

Dole.—From Slaymaker & Son, Dover, Del. Flowers imperfect. A variety having some promising characteristics. The plants are hardy, vigorous and productive. Berries medium to large, regular, oblong, light crimson, firm and of pleasant flavor. They are quite attractive in appearance.

Downing's Bride.—From M. Crawford, Cuyahoga Falls, O. Flowers imperfect. One of the most promising varieties fruited this season. It is vigorous, and has dense dark foliage strongly resembling Nick Ohmer in growth. The berries are medium to large, dark crimson, regular, conical, firm, and very attractive; flavor, good. The berries are not as numerous as on some sorts, but they hold their size through the entire season.

Dunlap (Senator).—From Flansburgh & Peirson, Leslie, Mich. Flowers perfect. Hardy; lacks a little in productiveness; fruit stems spindling. The berries are of medium size, irregular, oblong conical, somewhat necked; color, bright crimson; firm and solid; flavor, rather acid. The color, firmness and flavor make it a good canning berry, but it is rather rough for the table. The variety is of the Warfield type and was originated by J. R. Reasoner of Illinois.

Empress and Emperor were received from Flansburgh & Peirson, Leslie, Mich. Flowers perfect.

Empress is strong and hardy in plant. The fruit stems while strong and upright are not very numerous, but the size of the fruit makes up for the lack in numbers. The berries are dark crimson, large, regular, oblong conical; seeds deeply set and bright colored; very attractive in appearance. The texture is firm and the flavor good, making it a good all around variety.

Emperor is very similar in growth, but the plants are more productive and the fruit is a little more irregular and rough in appearance. The quality is good and it is a very promising sort.

With good culture they are valuable medium to late varieties.

George's Triumph.—From Harrison & Sons, Berlin, Md. Flowers imperfect. Appears hardy and has a tendency to set too much fruit. The berries are slightly irregular, oblong conical, somewhat necked, and shouldered; dark crimson; firm, flavor, good. They are rather rough to be attractive, but are quite promising in quality and productiveness. If the plants have sufficient vigor to mature all the fruit they set, it will be a heavy cropper.

Gibson.—From Flansburgh & Peirson, Leslie, Mich. Flowers perfect. The plants made very few runners, and have a course, dense, dark-colored foliage and superabundance of fruit stems. The fruit is large, crimson in color, regular round conical, attractive and of good quality. If it develops more hardiness it will be a valuable variety of the class of the Marshall, which it resembles closely, except that the flesh is a little higher colored.

Gladstone, from the same growers, is another perfect-flowered sort of much promise as a medium early variety. The plants seem to lack in hardiness, but recuperate readily in the spring and make a good growth. The fruit stems are long, slender, spreading and well loaded with large, irregular, round conical berries. The color is light scarlet; texture, firm; flavor, very pleasant, desirable. They are sometimes a little rough, but they hold their size through the entire season. The variety originated in Columbia county, Pennsylvania.

Joe.—From Slaymaker & Son, Dover, Del. Flowers perfect. Healthy, strong vines; fruit stems scattering, upright, stout and well loaded. The fruit is very attractive, large, bright crimson, regular oblate conical, firm, but has rather an acid flavor.

Kansas.—From W. F. Allen, Salisbury, Md. Originated in the state after which it is named. Flowers imperfect. Plants are very vigorous but form too many fruit stems to produce large fruit. The berries are small to medium in size, slightly irregular conical, bright crimson, firm and solid; flavor too acid for general use. Under special culture the size might be improved, but under ordinary care the fruit is very small.

Klondike.—From Flansburgh & Peirson, Leslie, Mich. Flowers perfect. The plants are good growers; fruit large, dark crimson, irregular round conical. The seeds are large, deeply set and bright colored, and give the fruit an attractive appearance. The pulp is firm and not very juicy. A promising late variety for market purposes.

Lady Jane.—Received from Harrison & Sons, Berlin, Md. Flowers perfect. The fruit is rather small and irregular; color, light crimson; rather soft; flavor, very pleasant; The vines are strong growers but seem to lack in productiveness.

Livingston.—From Flansburgh & Peirson. Flowers perfect. This variety was originated by C. W. Middleton, and is said to be a seedling of Warfield fertilized by Jessie. The vines are hardy, strong growers, and have a tendency to form too many fruit stems; berries, crimson elongated conical, very sweet and rich; rather soft for shipping. Excellent for canning. They have the Warfield shape but are slightly depressed at the apex.

Mammoth.—From J. H. Hale, South Glastonbury, Conn. Flowers perfect. The plants made a very weak growth and developed only a few flowers, 10 per cent of which were frosted. There was not enough fruit to properly judge of its quality.

McKinley and Mexican are two perfect-flowered sorts received from Flansburgh & Peirson, Leslie, Mich.

McKinley seems to be very hardy and prolific. The berries are large, oblong conical, irregular and rough; color light crimson, turning dark if left to fully ripen, when they become rather soft for a market sort. They are large and showy but lack in quality.

Mexican is a very upright, strong-growing plant with very few runners. The berries are large, regular, round conical; color, light crimson; seeds are large, scattering; pulp a little soft but of delicious flavor. It seems to be especially adapted to hill culture.

Mrs. McDowell.—From M. Crawford, Cuyahoga Falls, O. Flowers perfect. The vines appear to be hardy and throw a superabundance of bloom. The berries are medium to large in size; form, irregular, oblong conical; color, light scarlet; seeds on the surface. The pulp is rather soft, sweet and pleasant. Many of the berries are hollow, and their irregular, rough appearance is against them as a market sort.

Nettie.—From Slaymaker & Son, Dover, Del. Flowers imperfect. Lacks in hardiness and productiveness. The fruit stems are strong and upright, but few in number. Berries are large to very large, coarse and irregular in form, many being fan-shaped, somewhat necked; seeds, large, deeply set; color, light red. They are very sweet and pleasant when fully ripe, but are often hollow and soft.

New York.—From W. F. Allen, Salisbury, Md. Flowers imperfect. On our grounds this variety has not showed up equal to the claims of the introducers. The plants are very vigorous and hardy, but they form few fruit stems and only mature a portion of the fruit. The berries are medium to large, dark crimson, elongated, round conical, with a well-marked neck. They are of good flavor, firm in texture and attractive in appearance.

Parson's Beauty.—From Harrison & Sons, Berlin, Md. Flowers perfect. The berries are medium to very large in size, dark glossy red in color and thickly seeded; shape, irregular, oblong conical, broad at apex, somewhat shouldered and necked; flavor, mild and desirable. The husk is large and coarse, tending to prevent the berries from packing closely in the boxes. The vines are among the stronger growers and produce numerous stiff, upright fruit stems well loaded with good-sized berries.

Pennell.—From Flansburgh & Peirson. Flowers perfect. Promises to be of some value. The fruit is medium sized, dark red, firm, and has a sharp acid flavor that is desirable in a canning sort. The plants are not large, but are vigorous and appear very hardy.

Pocomoke.—From Flansburgh & Peirson. Flowers perfect. The berries are medium sized, dark red, rather thickly seeded, long, conical, shouldered and flattened or fan-shaped. They are too rough in appearance to be attractive, but are extremely productive and have a desirable flavor.

Reba.—From Slaymaker & Son, Dover, Del. Flowers imperfect. Seemed to lack in hardiness and productiveness. Only two good plants came through the winter, and they did not mature fruit enough to properly judge of their merits. The berries were regular, round, conical; color, dark; lacking in firmness; flavor, good.

Repeater.—From Flansburgh & Peirson. Flowers perfect. The fruit stems were abundant and were well filled with fruit, but the plants were too weak to carry the crop. The berries are small, thickly covered with small seed; shape, regular, conical; texture, firm, and flavor pleasant. A stronger growth of plants might develop larger berries, but they were too small to rank among the desirable sorts.

Robbie.—From Slaymaker & Son, Dover, Del. Flowers imperfect. It developed strong, healthy plants and upright, stout fruit stems. The berries were produced abundantly, but their roughness and light color are against them for market purposes. The size and quality was about medium.

Rough Rider.—From Flansburgh & Peirson, Leslie, Mich. Flowers perfect. Originated by Charles Leonard, a prominent grower in Oswego county, New York. Pedigree, Eureka, fertilized by Gandy. The plants are hardy and vigorous like Eureka, but the fruit resembles Gandy in color. Berries elongated, conical, regular; color, light crimson; seeds, large, deeply set; texture, firm. The plants appear somewhat deficient in productiveness, but the fruit is attractive, and it promises to be a valuable late sort.

Seaford.—From Flansburgh & Peirson. Flowers imperfect. First named Lloyd by the originator, but afterwards sent out as Seaford. The plants appear to lack in hardiness, although they had plenty of vigor; fruit, medium to large, dark crimson, irregular, oblong conical; flavor, very rich and pleasant. They adhere strongly to the husk and have some admirable points. Could see no difference between this variety and Lloyd, received from M. Crawford.

Seedling No. 1.—A perfect flowered variety received from S. J. Lehman, Enon, O. The plants made a strong growth and threw out too many runners. The foliage is light colored, but healthy. The berries are bright scarlet, round, regular, rather soft; flavor, very pleasant. The variety is very productive and although rather small for market, it promises to be of some value as a home berry. A little small for market.

Shepherd.—From Slaymaker & Son, Dover, Del. Flowers imperfect. A strong grower. The fruit stems are short and well protected from frost by the dense large foliage. The berries are irregular, many broadened at the apex; color, light crimson; texture, solid; lacks in flavor. It has no especially promising characteristics.

Stella.—From Slaymaker & Son. Flowers imperfect. Fairly productive, but too rough and irregular to be of much value. The plants are strong growers and set a large amount of fruit. The berries are very rough, oblong conical, light colored and sour.

Stone 130.—From M. Crawford, Cuyahoga Falls, O. Flowers perfect. One of the most promising among the early varieties. The plants are extremely hardy, vigorous growers, and are very productive. The berries are of medium size, oblong and slightly broadened at the apex; color, light; seeds, numerous and deeply set; flavor, very pleasant, mild and sub-acid. The fruit holds its size well through the season.

Sunshine.—Plants received from Myer & Son, Bridgeville, Del. Flowers imperfect. Vines very strong, hardy growers and have a tendency to throw too many fruit stems. The berries are long, somewhat shouldered, conical, slightly flattened and occasionally coxcombed; texture, soft; flavor, not the best. They have a rough appearance owing to the seeds being deeply set. The plants are very productive but, in size and quality, the berries are not up to the standard.

Twilight.—From Flansburgh & Peirson. Flowers perfect. The berries are dark crimson, round, or slightly oblong, and very juicy; pulp is a little soft but it has a pleasant flavor. The plants were badly attacked by rust and seem to lack vigor. They form so many fruit stems that the berries are small.

Up-to-Date.—From W. F. Allen, Salisbury, Md. Flowers perfect. Lacks in growth of vines. The berries are small and of poor quality; color, light crimson; shape, round. Unless further trial shows an improvement in the growth of the plants and the general character of the fruit, this variety will be of no value here.

1901.—From Slaymaker & Son. Flowers perfect. Only a few plants were received and they made a poor growth, hence more time will be required to correctly judge of the merits of this variety. The plants lack in development of runners, fruit stems and foliage. The berries are small, irregular, light red, fairly good in flavor, but are lacking in numbers.

NOTES ON STANDARD VARIETIES.

Many of the older varieties are worthy of special mention and the following comments are made on their behavior and value as general purpose berries:

Beder Wood is a variety that is largely used as a pollenizer. The vines are vigorous and the blossoms supply a large amount of pollen. The berries have a desirable flavor, but are a little soft and rather light colored for the present demands of the market.

Brandywine for a home berry is excelled by but few varieties. Its attractiveness as well as its flavor makes it very desirable for home use and local market, but the softness of the pulp is against it as a long-distance shipper.

Clyde is a vigorous, hardy sort, but unless it is on strong, moist soil it sets more berries than it can mature. It is valuable as a fertilizer for pistillate varieties, and is a profitable market sort, under high culture. The light color of the fruit and softness of the pulp are its leading faults.

Crescent will thrive with as poor treatment as any pistillate variety grown, but given good care it is productive of firm attractive berries of medium quality. It has been superseded by Warfield in most places.

Enhance is of some value as a pollenizer and as a market variety, but there are several sorts that excel it in productiveness. It does not stand drouth well on dry soils. It is being used for experimental work as a double cropper.

Excelsior is one of the new bi-sexual early sorts of much value. It is a very vigorous grower and extremely productive of medium sized berries, but it is somewhat lacking in quality. It is a cross between Hoffman and Wilson.

Gandy stands among the better late sorts. The berries are attractive, large, of good quality and always bring a good price when well grown. It is especially valuable where the beds are only renewed once in three or four years.

Glen Mary is highly prized by some for its vigor, productiveness, and strength as a pollenizer. The berries are very large, highly colored and of good texture for a large berry. In some sections it is very susceptible to rust, which probably is one reason that it is not more largely grown.

Greenville seems to lack in hardiness, but when well grown, produces large and handsome berries. The berries are firm, good shippers, and in some sections it has superseded Bubach.

Haverland usually produces heavy crops of long, bright red berries. If it was a little firmer and better in quality, there would be none better for general culture. Under ordinary conditions it is one of the best varieties.

Marshall has established itself with the better growers as one of the best fancy berries; size, beauty and quality being its strong characteristics. It is not as productive as some other sorts, and it requires good soil and care, but when given proper culture there are few better kinds.

Mayflower is extremely hardy and is very productive, but the berries are rather small and lack in quality. It is a strong grower and may develop considerable value as a fertilizer.

Morgan Favorite is a large, stocky grower. It does not throw out many runners, but is fairly productive. The fruit is of good flavor and attractive in appearance.

Nick Ohmer is a large, attractive berry of good quality, but seems to lack in growth and productiveness unless given the best of care. When given special culture it is one of the best exhibition berries grown.

It is generally conceded that Parker Earle fails to mature all the fruit set. Its over productiveness is its greatest fault, and unless given the best hill culture or grown under other conditions equally as good, there are many varieties that surpass it.

Sample has proved itself to be a very valuable sort. It is hardy and productive of choice, attractive berries. It has large healthy foliage and stout fruit stalks. With strong soil and good culture it is one of the most promising kinds.

Stone Early is of about the same season as Michels and seems to have more vigor. It makes many plants and the fruit is generally a little under size. The quality is not the best, but is good for an extra early sort.

William Belt, for size, beauty and productiveness has few superiors. The quality is good, but there is a slight tendency to grow coxcombed. It does especially well on heavy, cool soil.

Woolverton, originated by John Little, Canada, still holds its place among the desirable sorts. The flowers are perfect and strong in pollen, making it desirable as a fertilizer. The fruit is usually large, uniform, of fine appearance and generally produced in abundance; quality is good.

Warfield and Haverland are probably more largely cultivated by the average grower than any other two varieties, as they do well with ordinary care, but given good culture they are both very desirable as canning and market berries.

SUMMARY.

In the place of some of the older early varieties, such as Michel Early or Beder Wood, Excelsior, Stone Early or Mayflower, which seem to have characteristics in some ways superior, might be selected.

For large berries of high quality, Marshall, Wm. Belt, and Sample are valuable, but for market berries where quality is desired, Excelsior for early followed by Warfield, Haverland, Clyde, Sample, Wm. Belt and Bubach will, with good culture, give desirable results.

Some of the newer sorts are promising, but need further trial. Senator Dunlap, Rough Rider, Empress and Parson's Beauty are all berries of much promise, but every grower should carefully select such varieties as are suited to his methods of culture and environments. There are varieties largely advertised by the introducers, such as Michigan, New York, Bobolink, Sunshine, and others that have not done especially well here, and need further trial.

Agricultural College, Dec. 31, 1901.

NOTES ON VEGETABLES.

BY L. R. TAFT AND M. L. DEAN.

Bulletin No. 196.—Horticultural Department.

In the spring of 1901 a large number of the vegetable novelties offered by various seedsmen were secured, and at the proper time the seeds were planted for comparison with the standard kinds. An unusually large number proved to be of value, and with very few exceptions the seed seemed to have been carefully selected and the plants were even and true to type.

The date of planting, time of maturity, height of the plants and the product are given in tabular form, and a list of the addresses of the firms from whom the different varieties were secured is appended.

NOTES ON BEANS—1901.

GREEN PODDED SNAP VARIETIES.

Early China, from Weeber & Don, is one of the earliest sorts to mature. It is desirable either for string or for shell-beans. Very prolific. The beans are pure white. Edible July 12.

Giant Stringless, received from Vaughan, is true to its name in having giant pods. They are long, broad, stringless and tender. A very prolific sort with a long period of edible maturity. Edible July 18.

Golden Crown, from Thorburn, is a very prolific variety. The pods are long, tender, and light green in color, rather than yellow as the name would indicate. Edible July 16.

Longfellow, from Vaughan, produced an enormous amount of tender, pleasant flavored pods. The pods were edible July 16, long, straight, round and stringless, and remained edible as long as any of the green podded varieties.

Mohawk, from Ferry, was one of the quick maturing sorts of medium quality. The pods are dark green, long, flat and straight, but become tough in a short time. Very productive. Edible July 14.

Smart's Hybrid, from Childs, has strong and rapid growing vines, but is not as productive as some sorts. The pods are long, bright green and tender, but the flavor is strong. Slightly stringed. Edible July 18.

Stringless Green Pod, from Burpee, is a rapid grower and very productive. The pods are long, bright green, round, very tender and entirely stringless. A promising new variety for garden purposes, while its productiveness and quality will make it valuable for the market gardener. Edible July 15.

Triumph of the Frames, from Vaughan, is a small growing, early sort, of no special value. The pods are short, small and lack in quality.

DWARF WAX VARIETIES.

Davis and Detroit Wax, from Ferry, in productiveness and quality have few superiors among the wax beans. Edible July 14.

German Wax, from Ferry, a black-seeded variety, is vigorous in growth and the pods are numerous, long, white, thick and tender. They ripened early, and were edible for a long period. A very desirable variety, owing to its quality and productiveness. Edible July 16.

Golden Cluster, from Ferry, is a desirable wax-podded variety. The vines are very prolific and strong growers. Edible July 18.

Ivory Pod, from Weeber & Don, is not very vigorous and lacks in productiveness. The pods are small, waxy white, nearly transparent, tender and pleasant flavored. Edible July 14.

Kidney, from Thorburn, is an old variety of high quality. The pods are long, waxy, tender and desirable; beans white and excellent for shelling. Edible July 16.

Round Kidney, from Johnson & Stokes, seems to be a selected strain of the Kidney Wax. It is very productive; pods round, waxy, thick and tender. Its edible duration is good. Edible July 17.

Twentieth Century, from Burpee. The vines are strong, upright, productive and thickly covered with foliage; pods, small, long, curved, round, thick, waxy and tender. A very desirable bean of its class. Edible July 18.

White Kidney, from Vaughan, seemed identical with Kidney, from Thorburn, and is a valuable garden bean. Edible July 17.

ENGLISH DWARF.

The English beans are upright, rank, bushy growers, and have large, oval, coarse pods. There are not many beans in a pod, and they are usually shelled and eaten as peas. They are rich in flavor and make a toothsome dish. Four varieties were received from Thorburn.

Broad Windsor reached a height of three feet, but was shy of pods. The pods were very large and broad, and contained one to three beans, some of which measured an inch in length.

Mazagan is one of the earliest maturing varieties. The plants, which are about two feet in height, are not very productive; pods, large, containing from one to three large beans. Edible August 1.

Small Horse is similar to Mazagan except smaller. Edible August 1.

Sword Long Pod has longer and more narrow pods. The beans are smaller, and about the same texture and quality as the other varieties. Edible August 8.

POLE VARIETIES.

French Yard Long, from Thorburn, has strong growing vines, but lacks in productiveness. The pods are long, very slender, round and tender, but the beans are poor in quality. Edible July 26.

New Early Dawn, from Livingston, is a quick growing, early maturing Lima bean of excellent quality.

Seibert, from Livingston, is a standard sort of choice quality. Edible July 26.

BUSH LIMA VARIETIES.

Willow Leaf, from Burpee, is a low-growing variety of no economic value. The leaves are long, slender and pointed; pods, short, with one to three white, tender beans of good flavor, but the plants are too small and too shy bearers to be of any special value. Edible July 28.

New Wonder, from Johnson & Stokes, is a strong growing bush sort of the Lima type. The vines were loaded with pods containing two or three beans of excellent quality. A desirable variety of this class. Edible July 24.

WHITE PEA.

White Bacon, from T. W. Wood & Sons, is a selected strain of the ordinary white pea bean. Edible July 16.

NOTES ON CAULIFLOWER, CABBAGE, ETC.

The experimental plat of plants of the cabbage family contained eighteen varieties of early cabbage, seven of medium, six of late and three of red cabbage; five of kale, three of kohl-rabi, five of Brussels sprouts, several varieties of broccoli from the United States Department of Agriculture, and a collection of cauliflower.

CABBAGE, 1901.

Early varieties. (Planted April 16.)	Seedsmen.	Date.		Number of days to maturity.	Per cent of plants headed.	Average weight of heads in pounds.
		First mature head.	Market maturity.			
All Head Early	Vaughan	July 10	July 18	86	75	4
Alpha	Currie Bros	" 4	" 16	80	55	3.1
Early Drumhead	Dreer	" 12	" 22	88	90	4.8
Early Drumhead	Ferry	" 10	" 18	86	85	4.56
Early Flathead	Burpee	" 8	" 20	84	60	4.1
Earliest	Gregory	" 4	" 10	80	60	3.6
Earliest Giant	Vaughan	" 14	" 26	90	80	4.4
Early Jersey Wakefield	"	" 2	" 14	78	98	4.2
Etampes	"	" 6	" 12	87	82	3.4
Eureka	Harris	" 4	" 14	82	85	3.10
Express	Vaughan	" 4	" 14	82	94	3.1
Foremost	U. S. Department	" 6	" 18	82	65	3.6
Henderson's Early Summer	Vaughan	" 4	" 16	80	95	4.2
Large Wakefield	Ferry	" 8	" 20	84	85	4.6
Little Pixie	Weeber & Don	" 1	" 12	76	65	2.8
Seventy-eight	Burpee	" 4	" 18	80	82	3.9
Twentieth Century	Vick	" 8	" 20	84	85	4
Volunteer	Rawson	" 6	" 18	82	70	3.8
Medium varieties. (Planted April 28.)						
All Seasons	Ferry	Aug. 2	Aug. 12	96	80	6.2
Autumn King	Vaughan	" 1	" 14	95	90	6.8
Limited Mail	Holmes	July 26	" 10	89	75	5.8
Lupton	Maule	Aug. 4	" 20	98	89	6.75
Nameless	"	July 30	" 14	93	80	5.6
Succession	Vaughan	Aug. 8	" 24	102	92	7.1
Vandergaw	"	" 6	" 20	100	90	6.1
Late varieties. (Planted July 2.)						
Diamond Winter	Gregory	Sept. 30	Oct. 10	89	78	7.6
Dutch Winter	Vaughan	Oct. 2	" 16	91	85	8.2
Flat Dutch	"	" 4	" 14	93	90	8
Ideal Winter	"	" 6	" 16	95	80	7.75
Mammoth Rock Head	Johnson & Stokes	" 1	" 12	90	85	6.9
Premium Flat Dutch	Vaughan	" 2	" 12	91	95	8.5
Red. (Planted July 2.)						
Niggerhead	Elliott	Sept. 8	Sept. 20	67	50	3.2
Red Hollander	Currie	" 28	Oct. 10	87	75	4.8
Red Polish	Maule	" 20	" 4	75	68	3.8

EARLY VARIETIES OF CABBAGE.

Little Pixie was the first variety to reach edible maturity. The heads are small, but very solid, white and tender. Early Jersey Wakefield was only two days later, and the size of its heads and their quality are much in its favor.

Seventy-eight, received from W. Atlee Burpee, was only two days behind Early Jersey Wakefield, and the heads were nearly as large, firm and of very fine quality. The plants are strong and the upright habit of the foliage will permit of close planting. It comes in the season of Henderson's Early Summer, but will hardly take its place.

Alpha, Earliest, Eureka and Express all reached maturity at the same time, and have some value.

Foremost, received from the United States Department of Agriculture is of the Jersey Wakefield type. The heads were small, hard and crisp, but not as good as Wakefield for early use.

Twentieth Century, from Vick, is a desirable early sort of the Early Summer type. The heads are about the same size and equal them in quality, but a smaller per cent of the plants produced heads.

The other early kinds have been previously described. Most of them have some value, but none equal Wakefield or Henderson's Early Summer.

MEDIUM VARIETIES.

All Seasons, Autumn King, Succession and Vandergaw are among the better sorts of this class. They are of strong growth and generally develop a large per cent of valuable heads. If sown late they can be kept for winter use. Lupton is also a valuable sort, but Nameless produced rather small, soft heads.

LATE VARIETIES.

The six varieties tested are standard sorts and are valuable late keeping kinds.

RED VARIETIES.

Niggerhead is a dark, purplish-red cabbage. The heads are small, hard, deeply colored, crisp and tender.

Red Hollander and Red Polish are two good varieties of this class. There is not much demand for red cabbages, but the above are among the desirable kinds.

KALE.

While Kale is not very commonly grown, those who are familiar with its use esteem the three dwarf varieties, Curled Scotch, Brown and Moss very highly. They differ principally in their color, all being low-growing, spreading and very attractive.

Green Curled is a tall variety much resembling Dwarf Scotch, except that it is taller and larger, the plants sometimes measuring three feet across.

Siberian is a tall, coarse-growing sort, which is quite strong in flavor.

After being frosted the kales may be cooked the same as cabbage or used as greens or salads, and are much relished.

KOHL-RABI.

Of this vegetable three varieties, Early Purple, Early White and Large Green were grown. They are of easy culture and are cooked the same as turnips, to which they are greatly preferred by many. The Early Purple and Early White are quick-growing varieties and differ only in color. Large Green has tall, coarse tops. The edible portion is of poorer quality than the varieties named above.

BROCCOLI.

Several varieties were received from the Department of Agriculture in 1900. They were tested last season but failed to produce heads. This year the trial was repeated with the same results. The plants made a rank, bushy growth, but no heads were produced. In some sections they succeed better than cauliflower.

BRUSSELS SPROUTS.

Hercules and Long Island, from Vaughan, and Improved Dwarf, Paris Market and Tall, from Weeber & Don, comprised the varieties grown. They all made a vigorous growth, but the small heads were so loose, strong and poor in quality that they were not edible. The dry, hot weather in August and September was probably one cause of the poor quality.

CAULIFLOWER.

For several years the cauliflower has been so badly affected with black rot, a bacterial disease, that we have been unable to grow it here, but this year several varieties developed choice heads.

Early London, received from Thorburn, reached edible maturity first, and the heads were of excellent quality. While they were not very large, they were solid, white and tender.

Early Snowball, from Ferry, and New Snowball, from Vaughan, appeared to be identical and developed excellent heads.

Extra Early Dwarf Erfurt and Early Dwarf Erfurt matured a few small heads, but the tendency to break and start seed-stalks is against them for general use.

Dry Weather, from Burpee, has the same tendency as the Erfurts, the seed-stalks starting very soon after the heads reach edible size. The heads are small, compact and well covered by the foliage.

Copenhagen has its heads poorly covered by the foliage, and they are badly discolored by the sun if the leaves are not tied about them. The heads often burst and the seed-stalks start before they reach their full size.

Early London and the Erfurts are the most desirable early varieties, and Snowball is among the better general purpose varieties.

When planted on cool, moist soil, and given good culture, the cauliflower is usually a profitable crop, but it is far from reliable on dry soil in hot summers.

CHINESE CABBAGE.

The Chinese cabbage Pe Tsai, received from Vaughan, proved to be a vigorous growing form of wild mustard.

NOTES ON LETTUCE.

The table gives the general characteristics of the varieties previously grown here and the notes will include only the newer sorts and some of the standard varieties.

Big Boston is of the same type as Boston Market, but the heads are larger. The quality is no better, but the size makes it more attractive. For forcing it requires more room than the smaller heading sorts and is very susceptible to rot.

Bronze Curled, received from D. Landreth & Sons, is a promising new variety. The leaves are closely curled, but do not form a solid head; quality excellent. The borders of the leaves are of a delicate bronze tint. It is attractive and desirable.

Crystal Palace, received from W. A. Burpee, Philadelphia, seemed to be identical with Iceburg. It is a solid heading variety of excellent quality. The heads are very attractive, conical in shape, crisp and tender.

Leviathan, from Wm. Elliott & Sons, New York, is a very large heading sort. The heads are broad, solid, and enveloped by the outer foliage, which completely blanch the centers, making them white, tender and crisp; flavor excellent. It is long standing and a desirable garden variety.

England, from Burpee, is a close heading sort of no special value, being inferior in quality to Crystal Palace and many others of similar type. Their dark green color with reddish brown tinted edges makes them quite attractive, but they are not sure headers, many plants being open and tough.

Everlasting, from J. A. Everitt, Indianapolis, Ind., is a smooth-leaved, close heading sort of promising characteristics. The heads are closely covered, well blanched, crisp, tender and mild flavored. It seeds slowly and stands dry weather admirably. A good main crop sort.

Golden Queen, from Vick Sons, is a very early heading sort. The heads are quite solid and have a small amount of superfluous foliage. The quality is good, but the smallness of the heads is against it.

Giant Glacier, from Burpee, is a heading variety of superior quality. The heads are solid, closely covered with the outside foliage; texture very crisp and tender. It does not seed readily and is a choice variety for general use.

Golden Gate, from Johnson & Stokes, Philadelphia, is a very attractive heading variety. The heads are not as solid as some, but are closely enveloped and the inner leaves are of a rich cream white color, very tender, crisp, and of pleasant flavor. It is long standing and desirable.

Maximum, from J. C. Vaughan, is a very large, hard heading sort of desirable quality. It stands a long time before the seed stalks start, and does not get tough and strong as readily as some.

Milly, from Vaughan, is a small, loose heading sort. The leaves are smooth—edges deeply serrated; heads small, tender and crisp; flavor mild. It is of no especial value.

New Summerlead, from Johnson & Stokes, is a quick growing, open head, cutting variety. The leaves are broad, crinkled, tender and crisp. Seed stalks start rather early, but it is an attractive early sort.

New Treasure, from Johnson & Stokes, is an attractive, desirable heading sort; the heads are solid, and tender and have a mild, pleasant flavor.

New York, also called Wonderful, from Burpee, produced very large heads, but they were loose and open and the inner leaves were tough and strong. It is strong growing and very resistant to dry weather.

Nos. 42 and 1901 were received from Burpee. No. 42 is a quick growing, loose heading variety of good quality, while 1901 is a rather slow growing head sort of promising characteristics.

Royal, from Vick Sons, has smooth leaves, which form close but not hard heads. The centers are yellowish-white, crisp and tender and have a mild, pleasant flavor. A valuable addition to this class.

Sumatra, received from D. Landreth & Sons, is a close heading sort of excellent quality.

LETTUCE, 1902.

Varieties.	Seedsmen.	Habit of growth.	Color.
All Right	Johnson & Stokes	Heading	Green with pink margin.
All Seasons	J. C Vaughan	Heading	Dark green.
Asparagus Cos	J. C. Vaughan	Open	Dark green.
Blonde Beauty	Hort. Department	Compact heading	Light green.
Big Boston	J. C. Vaughan	Compact heading	Light green.
Brown Dutch	J. C. Vaughan	Half heading	Dull green, red border.
Bronzed Curled	D. Landreth & Sons	Half heading	Green, bronzed edges.
Cream Butter	W. Atlee Burpee	Close heading	Light green.
Crystal Palace	W. Atlee Burpee	Close heading	Dark green.
Elliott's Leviathan	Wm. Elliott & Sons	Large hard heading	Bright green.
England	W. Atlee Burpee	Loose heading	Dark green, reddish brown edges.
Everlasting	J. A. Everitt	Close heading	Bright green.
Golden Queen	Vick Sons	Solid heading	Dark green.
Giant Glacier	W. Atlee Burpee	Solid heading	Light green.
Golden Gate	Johnson & Stokes	Close heading	Dark green.
Grand Rapids Forcing	Hort. Department	Open, spreading	Bright green.
Hanson	J. C. Vaughan	Solid heading	Dark green.
Hamilton Market	J. A. Bruce & Co	Open, loose	Bright green.
Iceberg	J. C. Vaughan	Close heading	Dark green.
Maximum	J. C Vaughan	Large, close heading	Dark green.
Milly	J. C. Vaughan	Small, loose heading	Light green.
Mignonette	Peter Henderson	Open, wrinkled	Purple tinted.
Morse	J. C. Vaughan	Open, wrinkled	Bright green.
Nansen	W. Atlee Burpee	Solid heading	Dark green.
New Summerlead	Johnson & Stokes	Open, loose heading	Light green.
New Treasure	Johnson & Stokes	Close heading	Dark green.
New York Cabbage	Hort. Department	Large, loose heading	Bright green.
No. 42	W. Atlee Burpee	Open, loose	Light green.
1901	W. Atlee Burpee	Close heading	Dark green.
Royal	Vick Sons	Loose heading	Dark green.
Simpson (Early Curled)	J. C. Vaughan	Loose heading	Bright green.
Simpson Black Seeded	J. C. Vaughan	Closely curled	Dark green.
Sumatra	D. Landreth & Sons	Closely curled	Dark green.
Sugar Loaf	Jas. J.H.Gregory & Son	Large, close heading	Green, purple tinted.

SUMMARY.

For early maturity, among the loose, open, crinkled varieties, Hamilton Market and Early Curled Simpson are desirable, but although a little later, Grand Rapids is more largely grown for forcing purposes than any other sort.

Giant Glacier, Golden Queen and Crystal Palace are choice varieties in the class with Cream Butter.

Among the larger kinds there are few better sorts than Leviathan, Maximum and New York.

NOTES ON PEAS.

Several of the varieties in the table that have been grown for a number of years and described in former bulletins will only be mentioned in a general way.

Advancer is a standard early sort. The pods are numerous and well filled with peas of medium quality.

American Wonder is more productive than Advancer and the peas are better in quality, but they do not yield as large a proportion of shelled peas. Both of them are among the more desirable early sorts.

Athlete, from J. C. Vaughan, Chicago, is an early maturing variety of fair quality. The vines are spreading and grow from eighteen to twenty-four inches high. The pods are rather scattering, slender at the stem end, and rather blunt at the apex, and poorly filled. The edible period is very short and the pods ripen at one time, which makes it of value as an extra early sort to be followed by other crops.

A No. 1, from Gregory, is very productive of pods, but they are short and poorly filled. The peas are large and of good quality.

Blue Imperial, from Weeber & Don, New York, has strong, dark-colored vines, averaging about two feet in height; pods numerous, broad, long and well-filled with tender, plump peas of good quality. Their length of edible maturity and high quality make them very valuable as a garden sort. They are strong growers and quite resistant to dry weather.

British Queen, another variety received from Weeber & Don, did not germinate well and, although a few vines reached a height of eighteen inches, they failed to develop any pods.

Champion of England is one of the tall, standard garden and market varieties. The vines are vigorous and productive and the peas are of high quality. Its period of edible maturity is quite long.

Claudit, received from Gregory, is a very productive variety. A large per cent of the seed germinated and the vines are strong and vigorous, averaging from twenty-four to thirty inches high. The pods are long, well-filled and give a large proportion of shelled peas, of superior quality.

Daisy, from Vick, is a choice wrinkled variety. The vines are strong and productive, and the peas tender and sweet. The quality, length of edible maturity and productiveness make it a valuable home variety.

Earliest of All (Alaska), received from D. M. Ferry & Co., is fairly productive and one of the first to mature. Although somewhat lacking in quality it is one of the best early sorts for market purposes, as the pods mature very evenly.

English Forcing, received from W. Atlee Burpee & Co., Philadelphia, produced numerous pods, well filled with sweet, tender peas. The vines are dwarf, dark-colored and vigorous, and it is a promising variety.

Giant White Sugar, from Thorburn, is a desirable large-growing variety, with sweet tender, edible pods. The vines are from two to three feet high and quite productive; pods long and broad, containing five to seven large, sweet, tender peas.

Gradus is a variety of high quality, but it has low germinating power, the seed rotting if the soil is wet and heavy. The vines are quite productive and the peas are among the best in quality. The same variety is sold as "Prosperity."

King of the Dwarfs, from Vick, is a cross between American Wonder and Little Gem. The vines are dwarf like those of American Wonder, but the peas resemble Little Gem, being quite short, and containing from five to seven small, tender peas. The plants lack in productiveness.

PEAS, 1901.

Varieties.	Seedsmen.	Per cent grew.	Date.		Number of days from planting to picking.	Pods.		Height of vines.	Length of edible maturity.	Average number of peas per pod.	Per cent of peas to total weight.
			First blossom.	First picking.		Length, inches.	Width, inches.				
Advancer	Ferry	98	June 8	June 19	56	2.75	.625	18-24	12	6	50
American Wonder	Vaughan	95	" 2	" 17	54	3	.625	12-18	8	6	45
Athlete	Vaughan	85	" 3	" 18	55	3.12	.85	20-24	4-6	5	34
A No. 1	Gregory	95	" 29	July 12	79	3	.66	18-24	6	4	25
Blue Imperial	Weeber & Don	94	" 15	June 20	57	3.6	.66	24-30	7	4-7	44.2
British Queen	Weeber & Don	40	July 3	Failed	to pod.	....	....	12-18			
Champion of England	Ferry	96	June 12	June 28	65	3	.75	36-40	10	5-8	43.1
Claudit	Gregory	94	" 6	" 21	58	3.12	.75	24-30	12	6-8	46.9
Daisy	Vick	92	" 17	July 6	73	4.25	1	12-18	12	7-0	53.4
Earliest of All	Ferry	98	" 4	June 16	53	2.75	.5	20-24	6-8	6	50
English Forcing	Burpee	96	" 6	" 21	58	3.5	.75	6-12	10	7	43.7
Giant White Sugar	Thorburn	90	" 14	July 3	70	4	.85	28-36	10-12	5-7	38.4
Gradus	Vaughan	55	" 8	June 28	65	4.25	.85	28-36	6-8	6	36.8
King of Dwarfs	Vick	98	" 4	" 26	63	3.25	.625	12-18	8	7	46.9
Teddy Roosevelt	Northrup, King & Co.	85	" 8	" 23	60	3	.625	20-26	8-10	5-7	46
Thomas Laxton	Currie	90	" 9	" 29	66	4	.85	24-30	10-12	8	40.6
Thomas Laxton	Vick	90	" 8	" 28	65	4	.75	18-24	10-12	7	40.6
Mammoth Grey	Thorburn	98	" 20	July 6	73	4.5	1	36-40	10	6-7	41.8
Market Garden	Ferry	97	" 14	" 3	73	2.85	.5	24-30	8-10	4-6	38.8
Master	Johnson & Stokes	95	" 15	" 5	75	3	.85	18-24	8-10	6-8	41.4
Matchless Wonder	Northrup, King & Co.	96	" 6	" 26	63	2.75	.5	24-30	10-12	6	53.1
Melting Sugar	Thorburn	95	" 15	" 6	73	4	.75	30-36	10	5-7	33
Midsummer	Salzer	94	" 16	" 5	73	4.23	.85	24-30	6-8	5-7	31.2
Monarch	Livingston	95	" 15	" 6	73	4	.375	30-36	8-10	4-6	38.9
Prolific Early Market	Livingston	96	" 12	June 27	64	2.85	.75	24-36	4-6	7	40.6
Prolific Giant	Rawson	95	" 16	July 6	73	4.25	1.125	40-48	8-10	4-6	20.5
Reliance	Burpee	98	" 15	" 3	70	3.25	.825	36-40	8-9	3-5	18.6
Scorcher	Salzer	96	" 6	June 26	63	2.75	.5	24-36	4-6	7	46.9
Stratagem	Ferry	78	" 16	July 5	72	3.85	.75	24-30	8-12	5-7	39.8
Surprise	Burpee	97	" 8	June 26	63	3.25	.625	20-24	6-8	6	40.6
Surprise, New	Vaughan	98	" 10	" 29	66	3	.625	20-24	6-8	5	46.9
Tall Erfurt Sugar	Vaughan	98	" 12	July 5	72	4	1.125	36-40	10-12	5-7	36.7

Teddy Roosevelt, received from Northrup, King & Co., Minneapolis. The vines are tall and spindling, with dense, light colored foliage. The pods are scattering, long, pointed at both ends; somewhat like Gradus, but more slender. The peas are of good quality.

Thomas Laxton, from Vick and also from Currie, is said to be a cross between Gradus and Extra Early. As compared with Gradus, the vines are shorter, but are about equally productive. The peas are quite sweet and the proportion of shelled peas to pods is larger than with Gradus. It promises to be a valuable early, wrinkled pea.

Mammoth Gray-Seeded Sugar, received from Thorburn, produced the longest pods of any variety grown. While tender, they are eaten the same as string beans. The vines were very strong, tall growers, and were heavily loaded with pods, which yielded a good per cent of shelled peas. These are large, tender and rich in flavor.

Market Garden, Hosford, is one of the best varieties grown, for market or home use. In productiveness and quality it has few superiors. It is largely grown for canning purposes.

Master, from Johnson & Stokes, Philadelphia, is one of the most promising new sorts. The vines are of medium height, strong, upright, branching, and densely covered with dark-green foliage. The pods are numerous, canoe-shaped and well filled with peas of superior quality.

Matchless Wonder is a strong grower and very productive of small, short pods, which yield a high per cent of shelled peas. These are small and somewhat lacking in quality.

Melting Sugar is another sweet, edible-podded variety. The pods are very numerous, but they are rough and irregular. The peas are large, tender and sweet, and the vines are quite tall and rank in growth.

Midsummer, received from John A. Salzer, La Crosse, Wis., has thrifty and productive vines. The pods are long, quite pointed at the stem end and blunt at the apex, well-filled with large, tender and sweet peas. The season, productiveness and quality make it a promising variety.

Monarch, received from the Livingston Seed Co., Columbus, O., has strong-growing vines, but lacks in productiveness. The pods are shaped much like those of Stratagem, but the peas are inferior in quality.

Prolific Early Market, received from the same firm, has medium sized vines which are very productive. The pods are short, but well filled with peas of low quality. It was one of the earliest to mature and this with its productiveness makes it a valuable early sort, especially for the market gardener.

Prolific Giant, from W. W. Rawson, Boston, has the largest and coarsest vines of any variety grown. The pods are canoe-shaped, tender, sweet and edible when small, but they mildewed badly and their irregular, wrinkled appearance destroyed their attractiveness. The peas were large, tender and sweet, but few in proportion to the bulk of the pods. Of no particular value.

Reliance was received from W. Atlee Burpee, and has small, rather spindling vines; foliage light green; pods short and well-filled, but lacking in numbers. The peas are of good quality.

Scorcher, from Salzer, is a quick growing and very productive variety. The period of edible maturity is quite short, and the peas soon become hard and dry. Their productiveness and earliness make it a valuable market variety.

Stratagem is one of the standard, main-crop varieties. It is a vigorous and productive plant and the peas are of good quality.

Surprise, from Burpee, and New Surprise, from Vaughan, proved to be nearly if not quite identical. New Surprise did not mature as quickly, and gave a larger per cent of shelled peas, but there seemed to be no difference in their quality. They are vigorous and productive varieties and as they mature early and evenly they are valuable for market garden purposes.

Tall Erfurt Sugar, from Vaughan, is an edible podded sort of little value. The pods are numerous, but they are poorly filled and as a rule are badly wrinkled.

SUMMARY.

For market garden purposes, where quantity and earliness are the chief considerations, Scorcher, Prolific Early Market and Earliest of All are valuable varieties, but for quality Gradus or Thomas Laxton are far superior, and they are nearly as early, although more care has to be taken to delay sowing them until the ground has become warm.

As mid-season, or main crop varieties, Hosford Market Garden, Master and American Wonder are among the better sorts.

Stratagem and Champion of England are standard late varieties, while Monarch and Blue Imperial are among the more promising of the new sorts.

NOTES ON SWEET CORN.

Champion, received from J. C. Vaughan, Chicago, Ill., is one of the desirable early sorts. The ears are of good shape and are well filled at both ends with tender, milky kernels of good flavor. The plants were free from smut and grew few suckers.

Country Gentleman, a standard sort which should be included in every garden collection. The kernels are long, tender and of the best flavor, remaining edible for a long period. It is the leading variety for the main crop.

Concord, an old standard second early variety, lacks in quality, but is a good general purpose sort.

Cosmopolitan, received from W. Atlee Burpee, Philadelphia, Pa., is a very promising, large-eared, early sort. The ears are symmetrical, and well filled at both ends; kernels broad, deep, tender and rich in sugar. The stalks are good growers and averaged one good ear per stalk.

Dreadnaught, from Burpee, is not a sugar corn, but is of the dent type. It strongly resembles the old Early Adams, except that the stalks are much coarser and stronger growers. The quality is such that it has no place among the desirable sugar corns.

Evergreen, is a selected strain of Stowell that produces ears of high quality, much earlier than the later varieties of this class. Valuable for market or garden.

Evergreen, Dobbin's Early, is identical with the above variety and is valuable as a medium, early variety of high quality.

Hickox is a variety maturing a little earlier than Stowell, and of nearly as good quality. If planted at the same time, they make a very good succession. Good for canning, market, or the home garden.

Mammoth, a very large-eared sort, follows Stowell. The ears are very large and well filled; kernels broad, deep, sweet and milky. It is the best late variety.

Metropolitan, received from J. C. Vaughan, Chicago, is a good second early sort. The ears are well filled with fine-flavored kernels. It is a true sweet corn, a good grower, free from smut, and a valuable acquisition to the large-eared early sorts.

Melrose, received from J. M. Thorburn & Co., New York, was somewhat affected with smut. It is a mid-season variety of medium quality. The ears are well covered, but the kernels are a little tough and lacking in sugar.

Minnesota is an old standard market sort and needs no description. The long ears of medium quality, and its productiveness make it valuable for the truck gardener.

Number 7, received from F. B. Mills, Rose Hill, New York. The stalks are tall, strong growers; ears long, uniform, slightly tapering; kernels are broad, short, tender and sweet. It is very much like Minnesota, but a little later, larger and better in quality.

Old Colony is one of the best second early varieties. The kernels are very white, sweet and tender.

Peep of Day, showed no improvement over last year relative to the amount of smut. The ears are small, and the kernels lack in quality. Of no value except as an extra early sort. It is not a genuine sugar corn.

Sheffield, received from W. Atlee Burpee, Philadelphia, is said to be a cross between Cory and Early Adams. It is desirable for productiveness and quality. The ears are of good size and the kernels milky and sweet.

Stowell is the leading variety for canning, market or home use, and needs no description. The attractiveness of the ears, the quality of the kernels and its productiveness place it at the head of the list of desirable general purpose varieties.

Triumph, from T. W. Wood & Sons, Richmond, Va., does not promise to be of any special value. The ears were not well filled at the tips; the kernels are short and rounded and are of inferior quality. There are many better varieties for ordinary use.

White Cory (Mammoth), still stands as one of the leading extra early sorts.

For a succession during the season White Cory, Champion and Sheffield are desirable early sorts. Evergreen, Hickox and Country Gentleman are among the best for mid-season; Stowell and Mammoth for late.

SWEET CORN, 1901.

Varieties.	Seedsmen.	Number of ears per square rod.	Number of days from planting to edible maturity.	Average.			Number of rows of kernels per ear.	Length of kernels, inches.	Diameter of cob, inches.	Weight of ears, ozs.
				Height of stalks, feet.	Number of ears per stalk.	Length of ears, inches.				
Champion	J. C. Vaughan	97	83	6	1.25	7.75	12	.5	1.125	10.25
Country Gentleman	D. M. Ferry & Co.	123.5	93	7.3	1.5	7.5	16	.5	.875	9.25
Concord	D. M. Ferry & Co.	99.3	89	9.75	1	10	14	.375	1.125	12.25
Cosmopolitan	W. A. Burpee & Co.	91	86	6	1.2	8.65	12	.56	1.25	11.9
Dreadnaught	W. A. Burpee & Co.	87	93	9.16	1.25	8.75	14	.5	1	12.8
Evergreen	D. M. Ferry & Co.	103.5	81	8	1.2	8.12	16	.45	1	12.8
Evergreen Dob. Ey.	J. C. Vaughan	98	80	7.5	1.12	7.75	14	.45	1.25	12.66
Hickox	D. M. Ferry & Co.	113	89	6.16	1.125	10.5	12	.375	1.125	12 5
Mammoth	D. M. Ferry & Co.	115	108	7.3	1.3	11.5	16	.5	1	15.5
Metropolitan	J. C. Vaughan	101	92	5.87	1.16	7.75	10	.375	1.25	9
Melrose	J. M. Thorburn & Co.	103	90	6	1.2	7.7	12	.375	1.625	11
Minnesota	D. M. Ferry & Co.	111.6	89	5.6	1.75	7.6	10	.5	1	1.1
Number 7	F. B. Mills	105	93	7.25	1.5	9.2	10	.44	1.125	11.5
Old Colony	D. M. Ferry & Co.	113	88	6	1.125	8.8	16	.437	1.125	11.5
Peep O'Day	J. C. Vaughan	101	70	4.3	1.66	4.6	8	.43	1.125	10.3
Sheffield	W. A. Burpee & Co.	99	83	7	1.25	8.5	12	.43	1.125	13 66
Stowells	D. M. Ferry & Co.	121	103	7.6	1.5	9	16	.5	1.125	13.66
Triumph	T. W. Wood & Sons.	117	81	7.3	1.5	9.2	10	.43	1	9.66
White Cory (Mam'th)	D. M. Ferry & Co.	103	76	4.5	1.25	6	10	.375	1	5.66

POTATOES.

Acme, from G. W. Mace, Greenville, O., was true to type and made a rank vigorous growth. The tubers matured early and are of good shape and quality. They are well bunched in the hill and can be planted closely in the row.

Daughter of Rose, from Salzer, is a seedling of the old Early Rose, and resembles it very closely. Not as quick to mature as some other early sorts, but the quality is good.

Eureka, from W. A. Burpee, Phila., was of strong growth and seemed to be resistant in a marked degree to the attack of the potato beetle. The tubers are irregular, oval, slightly flattened; skin smooth, with minute dots and netted patches. The eyes have pink markings, and are shallow. They mature quickly, yield well and are very dry and mealy when cooked. Of considerable promise.

Norwood, from W. W. Rawson, is of the Early Rose type. It was one of the most productive early sorts. The tubers are long, pinkish white; eyes shallow, slightly lipped, and have pink markings. The elongated regular form, smooth skin and excellent quality makes them an attractive and desirable variety.

White Ohio, from Mace, was identical with those grown several years. They have the roughened skin, and the same shape as Early Ohio, but are nearly pure white. They are a selected strain of the Early Ohio, and yield better. They are a good early sort.

Big Crop, from Mace. The vines are about two feet high, light green, strong, and rather branching; tubers large, nearly round at the seed end, tapering toward the stem; skin, pink tinted, a little netted but rather free from dots. The eyes are pink and rather deeply set which gives the tubers a rough appearance. The flesh is very white and dry. It is a promising sort.

Farmer's Favorite, from Hiler, has rather rough tubers; eyes deeply set, and shouldered. The skin is pinkish white, finely netted; flesh very firm; white and fine grained. The vines are strong, spreading well over the row thus shading the ground. The tubers are bunched in the hill, of uniform size and yielded among the best. The vigor, yield, and quality make it promising.

POTATOES—1901.

Early varieties.—Planted May 4.	Seedsmen.	Height and color of vines.	Date of maturity.		Yield per acre—bushels.			Average yield for 1900 and 1901.	General average.	No. of years averaged.
		Inches. L. G.—light green. D. G.—dark green. M.—medium. P.—purple.	Edible.	Market.	Large.	Small.	Total.			
Acme	Department	18-24..M.	June 30	July 10	126.99	23.32	150.31	152.9	136.91	6
Acme	Mace	18-20..M.	" 30	" 10	129.58	23.32	152.91			
Alexander	Department	18-20..D. G.	July 2	" 15	106.25	12.95	119.21	138.64		2
Andes	"	20-26..M.	June 30	" 10	124.4	12.95	137.35	159.38	144.61	5
Blush	"	18-20..D. G.	July 10	" 30	88.11	25.91	119.21	142.53	144.08	5
Bovee	"	12-18..L. G.	" 2	" 20	129.58	18.14	147.72	165.86	174.75	7
Coles	"	18-24..D. G.	" 1	" 16	176.23	23.32	199.55	177.52		2
Dawn	"	18-20..L. G.	June 30	" 10	116.62	10.36	126.99	160.34	136.68	4
Daughter of Rose	"	20-24..D. G.	July 20	" 30	228.06	49.24	274.71			1
Dew Drop	"	24-26..D. G.	" 4	" 24	228.06	23.32	253.98	191.78		2
Delaware	"	24.....M. D.	" 16	" 28	225.47	18.14	243.61	243.61	233.88	4
Eureka	Burpee	20-24..D. G.	" 10	Aug. 1	142.54	23.32	165.86			1
Garfield	Department	20-24..M.	" 20	" 14	176.23	23.32	199.55	189.18	216.39	4
Herrington Peer	"	22-26..M.	" 20	" 5	168.45	28.5	176.95	190.48	220.28	5
Honeoye Rose	"	20-24..M.	" 18	" 1	171.05	10.36	181.41	211.21	157.65	6
Hurst	"	18-20..D. G.	" 12	July 20	165.86	10.36	176.22	194.37	189.83	4
Irish Cobbler	"	12-18..D. G.	" 12	" 20	186.06	20.73	207.33	164.57	174.33	6
Kansas	"	18-20..L. G.	" 16	" 30	114.03	5.18	119.21	145.13	150.73	5
May	"	12-18..L. G.	" 4	" 20	155.51	46.65	202.16			1
Michigan	"	12-18..L. G.	June 28	" 10	186.6	33.69	219.29	204.24	185.87	6
Minneheha	"	12-14..L. G.	July 10	" 24	158.09	33.69	191.78	224.17	196.95	4
Montana Rose	"	12-18..L. G.	" 14	" 30	119.21	18.14	137.35	178.32	195.41	4
Norther	"	12-18..M. G.	" 6	" 18	155.51	25.9	181.41	190.48	202.19	6
Norwood	Rawson	18-24..D. G.	" 8	" 30	165.86	51.83	217.69			1
Ohio	Department	16-24..D. G.	" 1	" 18	150.31	15.55	165.86	174.93	156.76	4
Peachblow	"	20-26..D. G.	" 14	" 30	165.86	5.18	171.04	171.05	183.92	7
Pingree	"	18-20..L. G.	" 12	" 24	145.13	25.92	171.05	182.71	178.82	3
Pinkeye	"	20-24..D. G.	" 2	" 14	145.13	20.73	165.86	191.78	157.26	6
Quick Crop	"	14-18..D. G.	" 1	" 12	171.05	18.14	189.19	207.33	167.58	6
Richmond Belle	"	24-26..P. G.	" 10	" 24	103.66	7.78	111.44	115.33	152.26	4
Roberts	"	16-18..L. G.	" 18	" 30	155.51	15.54	171.05	207.33	157.48	4
Rosy Morn	"	12-18..L. G.	" 11	" 31	126.99	10.36	137.35	206.03		2
Salzer's Earliest	"	18-24..D. G.	" 6	" 16	132.17	5.18	137.35	161.98		2

Silver Crown,	“	18-20..M. G.	“ 2	“ 12	176.23	28.51	204.74	180.12	....	2
Six Weeks	“	20-24..M. G.	“ 20	Aug. 1	139.95	12.96	152.91	167.16	132.94	5
Snow Flake Jr	“	12-18..M. G.	“ 18	July 30	77.75	18.14	95.89	134.77	186.53	8
State of Maine	“	12-18..L. G.	“ 12	“ 30	95.89	7.77	103.66	128.28	130.22	4
Sunlignt	“	12-18..L. G.	“ 4	“ 14	150.31	18.14	168.45	215.10	....	2
Thoroughbred	“	18-22..D. G.	“ 3	“ 14	116.62	15.55	132.17	138.64	115.31	6
Triumph	Mace	12-18..M. G.	“ 8	“ 10	145.13	28.51	173.64	....	....	1
Trumbull	Department	18-24..D. G.	“ 14	“ 28	160.68	10.36	171.04	173.64	146.16	4
White Lily	“	20-24..D. G.	“ 12	“ 24	147.72	23.33	171.05	147.73	134.06	6
White Ohio	Mace	20-24..D. G.	“ 4	“ 18	191.78	36.28	228.06	178.82	146.16	4
Late varieties.—Planted May 31.										
Adirondac	Department	28..L. G.	Aug. 20	Sept. 1	59.6	25.91	85.52	174.94	172.33	6
Arizona	“	28..L. G.	“ 22	“ 4	46.65	46.65	93.30	168.46	153.93	5
Astonisher	“	30..L. G.	“ 28	“ 10	67.38	20.73	88.11	155.50	....	2
Battle's Best	“	27..L. G.	Sept. 1	“ 12	62.2	31.9	93.2	243.4	216.89	6
Beauty of Beauties	“	30..D. G.	“ 1	“ 10	38.87	25.91	64.78	112.73	143.05	5
Big Crop	Mace	23..L. G.	“ 4	“ 16	88.11	33.69	121.85	....	....	1
Burpee's Superior	Department	24..D. G.	“ 2	“ 15	33.69	31.1	64.79	136.92	113.16	3
California Russet	“	24..D. G.	“ 2	“ 14	31.1	31.1	62.2	174.93	174.5	3
Cannon Ball	“	28..D. G.	“ 10	“ 28	72.56	18.14	90.7	189.18	....	2
Carman No. 1	“	28..D. G.	“ 1	“ 14	88.11	20.73	108.85	150.32	199.58	8
Carman No. 3	“	30..D. G.	“ 1	“ 14	98.48	25.91	124.4	196.60	262.7	7
Columbian	“	30..D. G.	“ 2	“ 12	77.75	25.91	103.66	155.50	....	2
Commercial	“	28..M. G.	“ 4	“ 16	108.85	25.91	134.76	204.73	212.5	3
Dewey	“	30..D. G.	“ 2	“ 14	67.38	28.5	95.89	177.94	206.46	3
Endurance	“	24..D. G.	“ 1	“ 15	57.01	31.1	88.11	119.21	118.76	5
English Schoolmaster	“	26..D. G.	Aug. 28	“ 6	36.28	25.91	62.2	152.91	....	2
Enormous	“	24..D. G.	Sept. 4	“ 16	....	33.69	33.69	104.95	131.765	6
Farmer's Favorite	Hiler	28..D. G.	“ 6	“ 26	173.64	33.69	207.33	....	....	1
Fottler's Peachblow	Department	24..D. G.	“ 1	“ 10	25.91	....	25.91	139.95	176 01	6
Free Silver	“	24..D. G.	“ 10	“ 23	80.34	28.5	108.85	173.64	196.96	3
Free Trade	“	24..D. G.	“ 7	“ 19	44.05	33.69	77.75	163.27	....	2
Gem of Aroostook	“	24..D. G.	“ 1	“ 15	98.48	46.65	145.13	222.88	....	2
German Rose	“	24..D. G.	“ 2	“ 12	80.34	51.83	132.17	182.71	....	2
Good Times	“	20..D. P. G.	“ 8	“ 20	54.42	28.5	82.92	163.26	188.14	5
Green Mountain	Hiler	26..D. G.	“ 8	“ 24	176.23	25.91	202.14	....	....	1
Hewes	Department	24..D. G.	Aug. 28	“ 2	119.21	23.32	142.34	208.63	171.69	4
Hiler's Choice	Hiler	22..D. G.	Sept. 6	“ 18	204.74	25.91	230.65	....	....	1
Home Comfort	“	24..D. G.	“ 8	“ 19	101.07	20.73	121.8	....	....	1
Hoosier	Department	24..D. G.	“ 6	“ 16	59.6	33.69	93.29	159.44	106.99	4
Ideal	“	25..D. G.	“ 1	“ 14	44.05	33.69	77.75	119.22	....	2
Irish Mignon	“	22..D. G.	Sept. 1	“ 10	54.42	25.91	80.34	167.16	146.16	5
Junior Pride	“	24..D. G.	Aug. 10	Aug. 20	98.48	38.87	137.35	164.57	....	2
Joseph	“	24..D. G.	Sept. 1	Sept. 10	72.56	38.87	111.43	141.24	170.00	5
Kaiser Krone	“	26..D. D.	“ 6	“ 14	119.21	51.83	171.05	205.61	....	2

POTATOES—1901.—CONCLUDED.

Late varieties.—Planted May 31.	Seedsmen.	Height and color of vines.	Date of maturity.		Yield per acre—bushels.			Average yield for 1900 and 1901.	General average.	No. of years averaged.
		Inches. L. G.—light green. D. G.—dark green. M.—medium. P.—purple.	Edible.	Market.	Large.	Small.	Total.			
Keystone	Department	28..D. G	Sept. 1	Sept. 10	51.83	25.91	77.75	145.13	....	2
King of Michigan	"	28..D. G	" 2	" 12	108.85	41.46	150.31	207.33	....	2
Leonard	"	28..D. G	Aug. 26	" 4	98.88	25.91	124.39	152.91	172.6	5
Lincoln	"	26..D. G	Sept. 1	" 9	72.56	28.5	101.06	156.79	163.22	5
Livingston	"	26..D. G	" 1	" 12	82.93	23 32	106.25	169.75	224.82	4
Livingston Banner	"	24..D. G	" 1	" 10	93.3	31.1	124.4	178.83	240.58	6
Long Keeper	"	24..D. G	" 10	" 20	23.32	2.59	95.91	134.76	129.93	5
Maggie Murphy	"	24..D. G	" 6	" 18	129.58	25.91	155.49	220.29	215.59	6
Mark Hanna	Salzer	22..D. G	" 2	" 16	189.19	20.73	209 92	....	....	1
Marvelous	"	26..D. G	" 10	" 28	80.34	28.5	108.85	....	....	1
McKinley	Department	26..D. G. P.	" 6	" 18	134.76	15.55	150.31	204.74	202.14	3
Michigan Beauty	"	24..D. G	" 1	" 13	77.75	41.46	191.21	217.41	156.69	6
Million Dollar	"	22..D. G	" 10	" 20	225.47	25.91	253.98	277.30	....	2
Mills' Banner	"	24..P. G	" 1	" 13	171.05	25.91	196.96	194.37	179.26	5
Montana Wonder	"	20..D. G	" 1	" 12	69.96	18.14	88.1	106.25	132.82	4
No Equal	Hiler	30..D. G	" 1	" 20	202.15	23.32	225.47	....	....	1
Northern Beauty	Department	22..D. G	Aug. 20	" 2	67.38	38.87	106.25	....	....	1
Pan American	Hiler	24..D. G	Sept. 6	" 20	134.76	18.14	152 91	....	....	1
Padelford	Department	24..D. G	Aug. 20	" 1	44.05	31.1	75.15	138.65	161.54	5
Pat's Choice	"	29..D. G	Sept. 1	" 14	75.15	25.91	101.06	164.56	....	2
Peachblow	"	28..D. G	" 14	" 26	106.25	41.46	147.71	182.71	211.21	6
Perfection	"	24..D. G	Aug. 22	" 4	134.76	36.28	171.05	222.88	354.52	5
Planet Jr	"	24..D. G	" 28	" 8	82.93	36.28	119.21	150.31	131.35	5
Pride of Seneca	"	26..D. G	" 24	" 2	31.1	46.65	77.75	184.01	157.84	5.
Prince Bismarck	"	26..D. G	" 20	" 1	59.6	18.64	77.74	176.23	169.34	3
Rose of Erin	"	28..D. G	" 1	" 16	124.4	25.91	150.31	189.19	176.74	5
Rough Rider	Salzer	26..D. G	Sept. 10	" 22	90.7	23.32	114.02	....	....	1
Rural New Yorker No. 2	Department	28..D. G	" 1	" 12	139.95	25.91	165.86	173.64	187.21	12
Scotch Grey	Judd	22..D. G	" 6	" 18	75.15	15.55	90.7	....	....	1
Sir Walter	Department	28..P. G	" 2	" 10	38.87	20.73	59.6	136.06	153.77	3
Sir Walter Raleigh	"	28..D. G	" 4	" 16	119.78	25.92	217.7	251.39	203.91	5
St. Lawrence	"	26..D. G	" 8	" 28	62.2	20.75	82.93	155.50	....	2
Steuben	Hiler	28..D. G	" 10	" 21	124.4	20.73	145.13	....	....	1

Suffolk Beauty	Department	24..D. G.	Aug. 24	" 6	67.38	28.51	95.89	159.38	142.53	5
Sweet Home	"	24..D. G.	" 20.	" 1	72.56	18.14	90.7	169.75	....	2
Twentieth Century	"	22..D. G	Sept. 1	" 15	51.83	23.32	75.15	177.52	....	2
Uncle Sam	"	20..M.	Aug. 24	" 2	38.87	20.73	59.6	....	....	1
Venezuela	"	20..D. P. G	" 28	" 8	49.24	25.91	75.15	107.55	....	2
Washington	"	24..D. G	" 28	" 10	57.01	31.1	88.11	110.57	174.77	2
White Mammoth	"	26..D. G.	Sept. 1	" 12	88.11	18.14	106.25	107.98	188.27	3
White Rose.	"	20..D. G.	July 8	July 18	75.15	41.46	116.62	....	....	1

Green Mountain, from Hiler, has been one of the standard market varieties in some sections for several years. They yield well, have a rough russeted skin, firm and are good handlers. They are a good size; a little rough and irregular, oblong, slightly flattened; eyes are strong, prominent, and start late, making them good keepers.

Hiler's Choice, from Hiler, is a very clear, white skinned variety. The eyes are shallow and broad. The skin is somewhat specked with fine dots. The vines are very rank and vigorous; tubers are scattered in the hill and grow close to the surface. The yield was very satisfactory, and their quality is such that it certainly promises well.

Home Comfort, from Hiler, has spindling branching vines; tubers, long, bright pink, with a reddish cast; skin, netted and somewhat russeted; eyes shallow, small, but strongly marked. The flesh is very white and floury, and the shape is such as to make them an ideal baking potato.

Mark Hanna, from John A. Salzer, La Crosse, Wis., is of the Carman type. They are good yielders, attractive in appearance and at the present time, fill the demands of the market potato. The quality is good, and their firmness denotes keeping qualities. They are certainly very promising.

Marvelous, from Salzer, has some qualities that make it worthy of further trial, although it gave us light yield. It is of a uniform, regular, oval rounded form, smooth skinned, shallow eyed, and fine textured.

No Equal, from Hiler, is a promising white potato. The vines are tall, upright growers, densely covered with light green foliage. The tubers are well bunched but rather deep; skin veined, and somewhat netted; eyes of medium depth, broad, open, strong, slightly lipped. Some of the eyes are on raised bunches giving a slight irregularity in shape, but generally they are uniform, oval, tapering toward the ends, and somewhat flattened. The quality and texture of the flesh are desirable.

Pan American, from Hiler, is an elongated, regular, round tuber. The eyes are broad, open, distinctively marked and usually set in broad, open depressions. The skin is white, finely veined, texture firm, flesh white. It has the markings of a good keeper. The vines are of medium strength.

Rough Rider, from Salzer, appears to be of the Sir Walter Raleigh type. The vines are dark green, strong and vigorous, tubers uniform, white, attractive and of excellent quality. It is a very promising variety.

Scotch Grey, received from G. J. Judd, Montrose, Mich., is a very attractive potato. The skin is clear cream white, eyes strongly lipped, broad, of medium depth, and have delicate pink markings. It is very solid and a good keeper. The vines are vigorous, of medium size, and spreading; tubers are of the Rural New Yorker shape, but less likely to grow rough and irregular.

Steuben, from Hiler, has rough, irregular shaped tubers. The skin is cream white specked with numerous russet dots; eyes narrow and shallow. They appear to be rather spongy, but the flesh is white and dry, and it appears to be of some value.

The early potatoes yielded well and the tubers were of superior quality; good size and attractive in appearance. A collection was sent to the Pan-American Exposition at Buffalo and was favorably commented upon by growers.

The conditions were such that the later varieties made a poor showing, and no opinion will be expressed upon the merits of the newer sorts, until they are given further trial.

Michigan is the leading white variety in yield (219.29 bu.) and earliness of maturity. Acme (152.91 bu.) and Andes (159.38 bu.) are excellent varieties. Cole (199.55 bu.) is one of the newer sorts that matured but a few days later.

Daughter of Rose (274.71 bu.) is second early, but gave the largest yield of any of the new varieties. Eureka (165.86 bu.) is somewhat earlier, but not as heavy a yielder. Ohio (165.86 bu.) still holds a place well to the front. White Ohio (178.82 bu.) gave a better yield. Sunlight (168.45 bu.) is worthy of trial, as also are several other of the early varieties.

Among the desirable late varieties are Carman No. 1 and No. 3, and Sir Walter Raleigh. Many of the newer kinds are of the same type and promise to be of value, as the market demands smooth, white potatoes, of oval shape, uniform size and firm texture. Mark Hanna, Marvelous, and Rough Rider all belong to this class. Scotch Grey is also similar.

TOMATOES—1901.

Advance has been one of the best standard early sorts. It is productive and smooth, but is rather small and soft.

Beauty is one of the most desirable light purple varieties. It is smooth, thick meated, compact, solid and of excellent flavor. The vines are strong growers and very productive, the fruits usually being in clusters. It grows admirably under glass.

Cream City, from Currie, is a vigorous, strong grower. The fruit is fairly smooth, firm, solid meated, and has a desirable flavor. It is not quite as smooth as Beauty, but is of about the same color and very productive.

Crimson Robe, from Salzer, is a smooth, crimson purple sort. The vines average over four feet in length, and were well loaded with solid, meaty fruit of superior quality.

Cumberland Red, from Landreth, is very productive, but rather rough and irregular to be attractive for fancy trade. The vines are of medium growth; fruit broad, flat, rather thin, a little rough, but solid, and in some sections is largely used by canners.

Early Michigan, grown last year for the first time, has again proved to be a valuable variety. The fruit is smooth, thick, meaty, of excellent flavor and of an attractive bright red color.

Earliana, from Gregory, is a bright purple, smooth, early sort of desirable quality and productiveness. This for an extra early, followed by Michigan, makes an admirable succession.

Excelsior, from Maule, and Excelsior Purple (White's) seem to be identical. They are productive and valuable varieties of excellent quality.

Enormous, from Maule, is a very large, bright red variety. The vines are extremely vigorous but lack productiveness. The fruit is large, thick, smooth at the apex, but somewhat wrinkled about the stem. The quality is medium but they are not as desirable as some of the other sorts.

Great Mississippi, from Childs, is another very large crimson red variety. It is more productive than Enormous, but is in texture and quality quite similar.

Hawley, from B. P. Hawley, Napoleon, Jackson Co., Mich., appears to be a selected strain of Ponderosa. They are very large, light purple, fairly smooth, thick and meaty, but not as productive as some of the smaller sorts. The quality is good for its class.

Ignotum and Potato Leaved Ignotum are long tried standard varieties that need no further praise.

Long Island (Bedell's), from T. W. Wood & Sons, originated on the island after which it is named. It is a valuable late sort, as it ripens evenly and is very free from cracking. The color is bright red; flesh, solid and thick; surface smooth. The vines are good growers and very productive.

Money Maker, from Landreth, is a red variety; surface, rather rough; apex indented. It is meaty, of medium flavor and is of some value as an early variety owing to its productiveness, but there are other smoother sorts that are more attractive.

Noble, from Burpee, is a bright red tomato of the type of Best of All. It is a vigorous grower and very productive. The fruit is medium to large, smooth, oval, very thick from stem to apex and meaty, but a little soft if not picked when first ripe.

Numbers 1, 2, 3, 4 are novelties from The Livingston Seed Co., of no especial value. They are all of the Honor Bright type, first turning yellow, then orange and finally red or purple when fully ripened.

Number 1 has foliage of the Potato Leaf type. The vines are dwarf, but very productive; fruit, flat, rough, rather soft and pulpy.

Numbers 2 and 3 were nearly identical; foliage Potato Leaf type; fruit, medium size, oval, smooth, firm and solid.

Number 4 had cut leaf foliage. It was very productive; form, flat, rather wrinkled and soft; turned to a yellowish purple color.

Ponderosa (Hendersons), Ponderosa Improved and Ponderosa Early are all of the same type. They are all very desirable large sorts, when well grown, but are sometimes slow to ripen and are injured by frosts.

Quicksure, from Dreer, matured the earliest of any of the large, extra early sorts. Not as productive as some, but the fruit is very large, a little rough, flat and meaty. Its size and bright red color make it very attractive as an extra early variety. The flavor is good.

TOMATOES—1901.

Varieties.	Seedsmen.	Fruit.			Vines.		Foliage.	
		Date first ripe.	Color.	Average weight, ounces.	Height, feet.	Habit: Up.—Upright. Sp.—Spreading.	Large, smooth, small, rough.	Margin.
Acme	Vaughan	Aug. 20	Red, dark	7.36	4.25	Sp.	Smooth, small	Deeply cut toward base of leaf.
Advance	Dept.	“ 12	Bright red	6.4	4.5	Sp.	Small, smooth	Cut shallow, irregularly.
Atlantic Prize	Ferry	“ 14	“ “	6.4	3.83	Sp.	“ “	Cut small, irregularly.
Beauty	Vick	“ 24	Bright purplish scarlet	7.87	4.16	Sp.	“ “	Inclined to be lobed.
Belmont	Gregory	“ 28	Red	8.	4.5	Sp.	“ “	Few cuts, but deep.
Bright and Early	Dept.	“ 15	Bright red	2.5	4.66	Sp.	“ “	Deeply serrated.
Brinton's Best	Holmes	“ 20	Red	7.6	4.83	Sp.	“ “	Serrated.
Best of All	Dept.	“ 26	“	9.2	4.5	Sp.	“ “	Cut, serrated.
Combination	Vaughan	“ 30	“	10.3	4.74	Sp.	“ “	Serrated.
Conference	Dept.	Sept. 1	Purplish	2.5	4.25	Sp.	“ “	Deeply serrated.
Cream City	Currie	Aug. 22	“	9.	4.66	Sp.	“ “	Cut.
Crimson Robe	Salzer	“ 23	Crimson purple	8.3	4.16	Sp.	“ “	Deeply cut.
Cumberland Red	Landreth	“ 24	Red	12.5	4.5	Sp.	“ “	Cut, slightly serrated.
Dominion Day	Bruce	“ 16	“	7.6	3.83	Sp.	“ “	Cut, finely serrated.
Dwarf Aristocrat	Vaughan	“ 28	“	6.1	3.33	Up.	Large, rough	Cut.
Dwarf Champion	“	“ 20	Purplish	7.	3	Up.	“ “	“
Early Michigan	Ferry	“ 12	Bright red	7.25	5.	Sp.	Small, smooth	Deeply cut.
Early Minnesota	N. K. & Co.	“ 13	Purplish	4.	5.	Sp.	“ “	Cut.
Early Bird	Dept.	“ 10	Purple	4.	4.75	Sp.	“ “	Deeply cut.
Earliana	Gregory	“ 13	Bright purple	8.5	5.	Sp.	“ “	Cut.
Excelsior (white)	Maule	“ 21	Purple	6.	3.	Sp.	“ rough	“
Excelsior Purple	Kansas Seed Co.	“ 19	“	8.6	4.33	Sp.	Large, “	Deeply cut.
Earliest of All	Dept.	“ 13	Red	4.6	4.16	Sp.	Small, smooth	Cut, slightly serrated.
Extra Early Purple	“	“ 21	Purple	6.25	5.	Sp.	“ “	Cut, serrated.
Enormous	Maule	Sept. 2	Red	12.8	6.	Sp.	Large, rough	Deeply cut.
First Early	Wood	Aug. 16	Purple	6.	4.41	Sp.	Small, smooth	Cut.
Fordhook Fancy	Burpee	“ 18	Red	6.5	3.	Sp.	Large, rough	Deeply cut.
Frogmore	Weeber	Sept. 2	“	6.5	5.66	Sp.	Small, smooth	Cut.
Great Mississippi	Childs	Aug. 28	Crimson red	10.1	5.16	Sp.	“ “	“
Hawley	Hawley	Sept. 4	Purple	12.5	4.	Sp.	“ “	“
Ignotum	Vaughan	Aug. 21	Red	9.5	4.5	Sp.	Large, rough	“
Kuttawa Dwarf	Dept.	“ 28	“	10.	3.8	Sp.	“ “	“
Landreth's Earliest	Landreth	“ 14	“	8.5	5.	Sp.	Small, smooth	“

Long Island	Wood	Sept. 1	"	10.5	4.	Sp.	" "	" serrated.
Long Keeper	Thorburn	Aug. 24	Purple	5.2	4.41	Sp.	" "	Serrated.
Lorillard	Dept.	" 20	Red	7.2	5.	Sp.	" "	Cut, serrated.
Magnus	Livingston	" 28	Purple	7.1	4.83	Sp.	Large, rough	Lobed.
Money Maker	Landreth	" 17	Red	7.7	6.	Sp.	Very small, smooth	Cut.
New Imperial	Maule	" 30	Purple	8.4	5.	Sp.	Large, rough	"
Noble	Burpee	" 19	Red	10.1	5.5	Sp.	" "	" serrated.
No. 1	Livingston	" 22	"	4.6	2.4	Sp.	Small, "	Deeply serrated.
No. 2	"	" 20	"	4.8	2.5	Up.	Large, "	" cut.
No. 3	"	" 20	Purple	4.2	3.	Up.	" "	Few large cuts.
No. 4	"	" 22	"	4.4	4.	Sp.	" "	Cut.
Optimus	Ferry	" 30	Red	7.9	6.	Sp.	" "	" serrated.
Perfection	Vaughan	" 18	"	7.2	4.5	Sp.	Small, smooth	Deeply cut.
Ponderosa	Dept.	" 30	Purple	18.7	5.	Sp.	" "	Cut, serrated.
Ponderosa Early	"	" 18	"	16.4	6.12	Sp.	Large, "	"
Ponderosa Improved	Vaughan	" 28	"	8.5	5.33	Sp.	Small, rough	"
Potato Leaf Ignotum	Dept.	" 18	"	7.5	5.33	Sp.	Very large, rough	" serrated.
Puritan	"	" 22	Red	8.5	5.	Sp.	Small, smooth	"
Purple Peach	Buckbee	" 26	Purple	2.2	5.5	Sp.	" "	"
Quarter Century	Burpee	Sept. 4	Red	4.8	2.5	Up.	Large, rough	" serrated.
Quicksure	Dreer	Aug. 14	Bright red	13.2	4.33	Sp.	Small, smooth	Serrated.
Red Granite	Salzer	" 4	Red	8.5	4.33	Sp.	Large, "	Cut, serrated.
Red Pear	Buckbee	" 19	"	3.	6.	Sp.	Small, "	"
Ped Plum	"	" 21	"	.3	5.5	Sp.	" "	Serrated.
Rosalind	Thorburn	" 30	"	8.6	5.	Sp.	Large, "	Cut.
Richmond	Landreth	" 18	"	9.5	5.33	Sp.	Small, "	"
Royal Red	Holmes	" 28	"	8.7	5.16	Sp.	Large, "	" serrated.
Ruby	Dept.	" 23	"	9.1	5.25	Sp.	Small, "	"
Shippers' Delight	Salzer	" 30	"	10.2	4.66	Sp.	Large, rough	Deeply cut.
Spot Cash	Dept.	" 21	"	5.7	4.5	Sp.	" "	Cut.
State Fair	"	" 26	Purple	9.5	6.	Sp.	" "	" serrated.
Stone	Vick	" 28	Red	8.5	5.	Sp.	" "	" deeply serrated.
Stirling Castle	Weeber	" 26	"	7.5	6.	Sp.	" "	Serrated.
Success	Burpee	" 27	"	8.5	4.16	Sp.	" "	Cut, serrated.
Ten Ton	Landreth	" 26	"	6.5	6.	Sp.	" "	Serrated.
Thorburn Novelty	Thorburn	" 30	Variegated	4.7	4.	Sp.	" smooth	Cut.
Truckers' Favorite	Burpee	" 28	Purple	8.5	4.33	Sp.	Rough	Deeply cut.
Trophy	Ferry	" 26	Red	8.5	4.	Sp.	Large, rough	Cut, serrated.
Vaughan's Earliest	Vaughan	" 10	"	4.	4.83	Sp.	Small, smooth	" "

YELLOW TOMATOES—1901.

Varieties.	Seedsmen.	Fruit.			Vines.		Foliage.	
		Date first ripe.	Color.	Average weight, ounces.	Height, feet.	Habit: Up.—Upright. Sp.—Spreading.	Large, smooth, small, rough.	Margin.
Clusterosa	J. and S.	Aug. 23	Orange	.8	6.	Sp.	Small, smooth	Deeply cut.
Egyptian Yellow	Dept.	" 16	"	7.	5.	Sp.	" "	" "
Golden Glory	"	" 18	Golden red	6.5	3.	Sp.	Large, rough	Cut.
Golden Prize	"	" 24	Orange	6.2	3.	Up.Sp.	" "	"
Honor Bright	Ferry	" 28	Yellow red	7.2	3.83	Sp.	Small, smooth	Deeply cut.
Lemon Blush	Dept.	" 23	Yellow	8.	5.	Sp.	" "	Cut.
Sumatra Fig	Salzer	" 26	Orange	.6	6.	Sp.	" "	"
White Apple	Ferry	" 30	Yellow	1.4	5.83	Sp.	" "	"
World's Fair	Dept.	" 27	Light yellow	6.5	2.83	Up.	Large, rough	"
Yellow Peach	Buckbee	" 24	Yellow	2.5	5.16	Sp.	Small, smooth	Deeply cut.
Yellow Pear	"	" 22	"	.45	6.16	Sp.	" "	Cut.
Yellow Plum	"	" 24	"	.6	6.	Sp.	" "	"

Red Granite, from Salzer, is true to its name in color; size, medium; shape, oval, flat at the blossom end, somewhat corrugated at the stem. The flesh is firm, solid, thick and meaty.

Rosalind, from Thorburn, is of bright rose red color, and one of the most promising varieties. It is very productive, smooth at both ends, firm, solid, oval shape, thick and meaty. The quality is desirable. The smoothness and color make it very attractive and the quality is excellent. It showed up much better than it did last year.

Ruby among the purple varieties, is what Beauty is in the red class. They are two very desirable sorts.

Shipper's Delight, from Salzer, is an attractive purple sort of good quality. It is of medium size, smooth, firm, and meaty. Of much promise.

Stone, bright red, oval, solid, firm, meaty, and productive. It is a standard red sort.

Stirling Castle, from Weeber & Don, is of the Conference type. It has a meaty shell, but is pulpy, soft and productive, but of no especial value.

Success, from Burpee, has vigorous vines, with coarse cut-leaved foliage. It is a very productive variety. The fruit is large, oval, very thick, and meaty, has a slight indentation at the apex, and shallow corrugations about the stem. It is of a bright, glossy red color, and the quality is excellent. One of the most desirable sorts.

Trophy is one of the older choice kinds. It is a sure bearer, smooth, thick meated, solid and of excellent flavor.

Vaughan Earliest is a quick growing, productive variety, and has been largely grown for an extra early, but there are many smoother varieties that are equal to it in quality and far superior in appearance.

Yellow Pear, Sumatra Fig, and Clusterosa appeared to be identical. They are a small pear-shaped yellow tomato of very choice flavor and are used largely for preserving, the quality being such that they excel other varieties for this purpose. Otherwise they have no value. Extremely productive and grow in clusters.

Yellow Peach and Purple Peach, from Buckbee, are the same except in color. The only striking characteristic of these varieties is their productiveness. The fruits are soft and pulpy and have a dull color somewhat resembling a peach, hence their name. They are a novelty of no especial value.

Golden Glory, Lemon Blush and World's Fair are among the better yellow varieties. They yield well and the fruit is smooth and of good quality.

There were ninety varieties of tomatoes in the experimental plot this season and it would be difficult to enumerate the best sorts, many of them being very desirable.

As mentioned in the brief notes, some of the older kinds are well known, but there are many newer sorts, which promise to be equal in every respect, and in some ways superior.

Beauty for a purple, Ruby, Stone or Trophy for red varieties have few superiors.

For a succession of desirable kinds, one could select Earliana, Early Michigan, or for extra large, though a little rough, Quicksure.

For the main crop, Noble, Rosalind, and Success are productive and of good quality.

Among the later varieties are those of the Ponderosa type.

Some of the seeds used in the experiments were saved by the department, some received from the Department of Agriculture at Washington, D. C., but the bulk of them were obtained from the following seedsmen:

John A. Bruce & Co., Hamilton, Canada; H. W. Buckbee, Rockford, Ill.; W. Atlee Burpee & Co., Philadelphia, Pa.; John Lewis Childs, Floral Park, N. Y.; Currie Bros., Milwaukee, Wis.; Henry A. Dreer, Philadelphia, Pa.; J. A. Everitt, Indianapolis, Ind.; D. M. Ferry & Co., Detroit, Mich.; James J. H. Gregory & Son, Marblehead, Mass.; Harry L. Holmes, Harrisburg, Pa.; Peter Henderson & Co., New York, N. Y.; Johnson & Stokes, Philadelphia, Pa.; D. Landreth & Sons, Philadelphia, Pa.; The Livingston Seed Company, Columbus, Ohio; Geo. W. Mace, Greenville, Ohio; Wm. Henry Maule, Philadelphia, Pa.; F. B. Mills, Rose Hill, N. Y.; Northrup, King & Co., Minneapolis, Minn.; W. W. Rawson & Co., Boston, Mass.; John A. Salzer Seed Co., La Crosse, Wis.; J. M. Thorburn & Co., New York, N. Y.; James Vick's Sons, Rochester, N. Y.; F. W. Wood & Sons, Richmond, Va.; J. C. Vaughan, Chicago, Ill.; Weeber & Don, New York, N. Y.

Agricultural College, Mich., Jan. 3, 1902.

SUGAR BEET EXPERIMENTS, 1901.

J. D. TOWAR.

Bulletin No. 197.—Agricultural Department.

CONTENTS.

The experiments recorded in this bulletin are as follows:

I. A test of eight varieties.
II. Trials of different dates of planting and averages of results for three years' experiments.
III. The average results of three years' experiments with different spacings of rows.
IV. An experiment with maximum, minimum and normal amounts of the several fertilizing elements with averages for three years.
V. An experiment to determine the effect of an excessive amount of each fertilizing element when used with normal quantities of the other two.
VI. A soil test experiment with fertilizers and averages for three years.
VII. A comparison with stable manures with other fertilizers with averages for three years.
VIII. An experiment on the influence of lime on the sugar beet.
IX. A comparison of nitrate and ammonia nitrogen.
X. The exhaustive effect of the sugar beet crop.
XI. Tables showing the variation in the sugar content of beets between September 10 and November 16, from plantings made on various dates in April, May and June.
XII. Table showing temperature, amount of rainfall and per cent of clouds from April 1 to December 1, 1901.
XIII. Shrinkage of beets in storage.
XIV. Miscellaneous experiments.
XV. Notes and analyses on diseased beets.
XVI. Illustrations showing the effect of size on the sugar content of beets.

VARIETY TESTS.

The variety test this year was conducted with seeds from eight different sources as shown in the tables below. The ground was a sandy loam which had been used for variety tests of clovers for three years previous. It received during the winter a moderate coating of stable manure in which there was a liberal amount of straw. The ground was plowed and sub-soiled, each to the depth of seven inches, April 19, followed promptly with the roller, and harrowed four times, twice with spring tooth harrow, and twice with the Acme. On May 13 the seed was sown. Two hundred pounds of fertilizer composed of one part of nitrate soda, two parts dissolved phosphate of rock, and one part muriate of potash was applied and harrowed in one week before sowing the seed. The field was divided into three sections, and six rows of each of the eight varieties were sown on each section; the order of arrangement being the same in each section. This method of seeding was simply to insure as near as possible uniform conditions for each variety. In one section a hill dropping attachment was employed by means of which the seeds were dropped at eight inch spaces. Observations at the time of thinning, however, proved that this method of seeding was of no advantage. In fact, it was concluded, that were the thinning to be delayed beyond the early part of the period for this operation, the bunchy growth would be injurious rather than beneficial, by reason of the fact that where so many beets are required to grow in a small space, none of them will do as well as they would were they grown singly. The hill dropping device did not seem to lessen the work of thinning. The beets were thinned on June 15. The other work of caring for the crop was performed in the usual way.

One section was harvested October 26, another November 6, and the last on November 16, giving a period of ten days between each of the times of harvest. The results in the table below give the total yield per acre, and the average analysis of the three dates of harvest. The results of fall growth gave us no data for general conclusions as to the proper time for harvesting. There was evidently a material growth of the crop during this period. The fluctuation in the percentage of sugar as modified by the weather conditions which will be shown in a table later on in this bulletin, go to show that the weather exerts a greater influence upon the time when beets may be most profitably harvested than the question of actual growth obtained by delay in this operation. The computed value of the crop as shown in the last column of the table is really the final test of the several varieties. It is interesting to note that the variety giving the highest money value of the final product is next to the lowest in yield of beets to the acre, but owing to its high sugar content, the value of the crop is brought above that of any other kind. The variety giving the second highest money value produces the largest tonnage, although falling near to the bottom in analysis. It is the opinion of the author that this crop of beets was a fair average of what might be expected from the best class of sandy loam soils in central Michigan.

The seed test in the following table was conducted by Prof. C. F. Wheeler, the Botanist of the Experiment Station, and all the sugar beet analyses given in this bulletin were performed under the direction of Dr. R. C. Kedzie, Chemist of the Experiment Station.

Results of variety test of sugar beets, 1901.

	Seed analysis.			Beet analysis.					
	Sprouts from 100 seed balls.		Average weight in field.	Average weight of samples.	Per cent sugar in beets.	Purity.	Value per ton at factory.	Yield per acre less 7 per cent tare.	Value of crop per acre.
	In 6 days.	Total in 21 days.							
			Ounces.	*Ounces.*				*Tons.*	
U. S. Dept. Agriculture, No. 5,771.....	106	117	13+	22	12.65	81.6	$4 71⅔	12.26	$57 83
U. S. Dept. Agriculture, No. 5,772.....	87	118	13—	23	12.71	79.2	4 73⅔	11.58	54 85
U. S. Dept. Agriculture, No. 6,359.....	132	157	15	26	10.84	77.5	4 11⅓	12.98	53 39
Austrian B. A.......	142	166	14—	20	13.51	79.7	5 00⅓	11.93	59 69
Austrian B. G. V....	147	171	13—	20	10.93	81.6	4 14⅓	11.98	49 64
Russian W. A. C....	151	177	13	21	11.13	75.8	4 21	12.24	51 53
Wohanka E. R......	58	82	17+	25	11.86	80.8	4 45⅓	12.26	54 00
Wohanka Z. R......	118	135	17—	24	11.67	82.2	4 39	13.42	58 91
Average.........	118	140	14+	23	11.91	79.8	$4 47	12.33	$55 06

The price used in determining the money value of the crop in this and all other tables in this bulletin is $4.50 per ton for 12 per cent beets and 33⅓ cents per ton for each per cent above 12.

DATE OF PLANTING.

The soil on which this experiment was tried is of a light, sandy loam nature, not by any means a soil that would be selected for the profitable growing of sugar beets. It furthermore has been cropped continuously with sugar beets for the past four years, although annually it has received an application of 500 pounds of fertilizer prepared by mixing one part of nitrate of soda, two parts dissolved phosphate rock, and one part muriate of potash. The field was given perfect care, cultivation by hand tools following the period of seeding as soon as necessary, and the thinning done with complete promptness about four weeks from the time each crop was sown.

In the continuous growing of beets on the same soil the development of fungous diseases and propagation of insect enemies has been under observation.

The leaf blight, a spot disease of the leaves—*Cercospora beticola,* Sacc.—appeared first, attacking every leaf, on the earliest plantings, but on the later plantings, although immediately adjacent, it developed no more than on new fields planted at the same time.

No insect enemies appeared on this or any of the Experiment Station fields except a few grasshoppers, which attacked a small planting of beets on a piece of muck land.

It was observed, however, that the beets planted early in the season and which were attacked by the leaf blight invariably showed a lower percentage of sugar than did those varieties which were planted later and escaped the attack of this fungus. The beets which showed the highest percentage of sugar were those which grew continuously throughout the season.

PHOTOGRAPHED JUNE 20—BEETS PLANTED APRIL 13 AND 24.

While the dates on which the plantings were made do not occur exactly the same each year, the average dates are the ones used in 1901. It will be noticed that the May 8 planting has given the highest yield of sugar, while the May 1 planting is but slightly behind. The yields decrease as we depart either way from the former date. The very early plantings, that is the middle of April have each year been followed by a week of favorable growing weather, while in each case, the planting of April 24 has been followed by unfavorable weather. From these figures it is readily seen as we concluded in a former publication that the time of profitable planting may be extended over quite a considerable area. It is safe to plant beets as early as the middle of April if the ground can be fitted at that time. After the 20th of May, there is a decided decrease in the final results.

Table showing the yields arranged as nearly as possible by weeks from the results of three years' planting together, with the final average.

Dates of planting.			1899.			1900.			1901.			Average.		
1899.	1900.	1901.	Yield per A.	Per cent of sugar in beets.	Sugar per A.	Yield per A.	Per cent of sugar in beets.	Sugar per A.	Yield per A.	Per cent of sugar in beets.	Sugar per A.	Yield per A.	Per cent of sugar in beets.	Sugar per A.
			Pounds.		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*
....	April 19....	April 13......	....	....	....	18,450	12.34	2,276.73	19,482	11.09	2,160.55	18,966	11.69	2,218.64
April 22.....	" 26....	" 24......	18,095	12.21	2,209.40	15,950	13.18	2,102.21	18,541	11.50	2,132.22	17,529	12.25	2,147.94
" 29.....	May 3......	May 1...	18,300	12.47	2,282.01	18,630	12.16	2,265.41	20,594	11.72	2,413.62	19,175	12.10	2,320.35
May 6.......	" 10......	" 8........	18,250	13.04	2,379.80	20,870	11.99	2,502.31	19,617	13.33	2,614.94	19,579	12.76	2,499.02
" 13.......	" 17......	" 15........	16,570	10.39	1,721.62	20,220	12.04	2,434.49	19,494	12.49	2,434.80	18,761	11.71	2,196.97
" 20.......	" 24......	" 22........	15,190	12.16	1,847.10	18,970	12.87	2,441.44	17,844	12.78	2,280.46	17,335	12.63	2,189.67
" 27.......	" 31......	" 29........	11,875	12.19	1,447.56	15,640	12.29	1,922.16	16,720	12.64	2,113.41	14,745	12.39	1,827.71
....	....	June 5........	....	....	....	....	....	....	13,787	12.19	1,780.64	13,787	12.19	1,780.64

There seems to be no rule nor conclusion relative to the sugar content of the beets as determined by these results. This is further proof of the perfect safety of using a number of dates for planting. The special advantage of planting at various periods is due to the fact that there is a longer period allowed for thinning the beets, and a more general distribution throughout the season of the work of caring for the crop. The early plantings are of advantage because they permit of getting the thinning done before the press of other work demands the time of the farm labor. It also allows the tops to get sufficient growth to completely mulch the ground before the weeds make their appearance, thereby diminishing the work necessary to keep the ground clean. The cut shown on page 188 is from a photograph taken on June 18, 1901, of the April 13 and 24 plantings showing the ground completely covered by the beet leaves. It will be observed that plantings as late as May 20 which will be ready for thinning by the 20th of June might seriously interfere with the busy haying season. Contrary to our expectations the earlier planted beets have given no indications of earlier maturity. As will be seen by the final average each year except one, the May 8 planting has given the highest percentage of sugar.

TRIALS WITH DIFFERENT SPACINGS OF ROWS.

In College Farm field No. 12, where a test of fertilizers was being made on four different one-acre plots, the chance to experiment with different spacings of rows was also utilized. On each of the four acres, one strip 12 feet wide (six rows) was sown to 24-inch rows, another 14 feet wide (8 rows) to 21-inch rows, and another 18 feet wide (12 rows) to 18-inch rows. The one-acre plots were 44 feet wide and 990 feet long. The results are given in the following table, showing the computed yields per acre, the per cents of sugar, the total yield of sugar, and the money value of the crop per acre from each method of sowing.

Table showing yields per acre and per cent of sugar from four series of plots with rows spaced 24 in., 21 in., and 18 in. respectively, and averages of the same.

	24-inch rows, 3-11 A.			21-inch rows, 7-22 A.			18-inch rows, 9-22 A.		
	Yield in pounds.		Per cent sugar.	Yield in pounds.		Per cent sugar.	Yield in pounds.		Per cent sugar.
	Per plot.	Per A.		Per plot.	Per A.		Per plot.	Per A.	
First series	6,845	25,098	16.23	7,820	24,577	16.09	10,090	24,664	14.95
Second series	6,230	22,843	15.85	7,390	23,226	16 17	9,740	23,809	15.17
Third series	5,950	21,817	15.64	7,060	22,189	15.86	9,405	22,990	16.45
Fourth series	4,580	16,793	15.98	5,630	17,693	14.14	8,659	21,166	14.97
Totals	23,605	86,551	63.70	27,900	87,685	62.26	37,894	92,629	61.54
Average		21,638	15.93		21,921	15.57		23,157	15.39
Average pounds sugar per acre		3,447			3,413			3,564	
Value of crop per acre			$52 04			$51 40			$53 61

From the figures at the bottom of the table the difference in the pounds of sugar produced per acre from the 24 and 21-inch rows is practically nothing. While the 18-inch rows give a yield of nearly 200 pounds of sugar more per acre than either of the other spacings. In thinning these beets the instructions to the thinners were to leave the 24-inch rows with six-inch spacings, the 21-inch rows with seven-inch spacings, and the 18-inch rows with eight-inch spacings. This method afforded practically one square foot of ground for each beet. The uniform results in per cent of sugar indicate that the beets had about an equal chance. That is to say the beets in the wider rows did not get a growth sufficient to decrease their sugar content.

It must be remembered, however, that the work of caring for a crop with the narrower spacings of the rows is proportionately larger, inasmuch as there are practically one-third to one-sixth more rows in the field than with the 24 and 21-inch rows.

From another series of plots, seventeen in all, the same spacing of rows was practiced, giving results as follows:

	Yields per acre.	Per cent sugar.	Sugar per acre.
	Pounds.		*Pounds.*
24-inch rows	11,356	14.30	1,624
21-inch rows	12,132	15.01	1,821
18-inch rows	12,948	14.52	1,880

The seed for this experiment was planted on June 8, and the fertility of the ground was such that a light yield only could be expected. This result, like the former, shows an advantage in favor of the 18-inch rows, while the 21-inch rows fall but slightly behind, being quite a good deal, however, in excess of the yield from the 24-inch rows.

An experiment of this nature was conducted in 1900 as reported in Bulletin 188, giving the results in yields of beets slightly in favor of 21-inch spacings.

Minnesota Experiment Station Bulletin 56 and Nebraska Experiment Station Bulletin 61 record experiments slightly in favor of 18-inch rows.

Considering the extra work involved in the narrowing the space between rows together with the inconvenience and even impossibility of cultivating with large farm horses in narrow rows, it seems as yet full as wise to continue with the rows 21 inches apart at least.

EXPERIMENTS OF MAXIMUM, MINIMUM AND NORMAL AMOUNTS OF SEVERAL FERTILIZING ELEMENTS WITH AVERAGES FOR THREE YEARS.

A light sandy soil which had previously been employed for growing a crop of lathyrus sylvestris was used for this experiment. The enormous growth of the lathyrus had left a large amount of organic matter in the soil, so that although the natural fertility of the land was not great, it was well supplied with humus.

The reader is referred more particularly to the averages for three years which occur in the last three columns of the following table. It will be seen that while there is some relation between the tonnage and sugar content of the crop, high tonnage does not always go with a large per cent of sugar. The actual number of pounds of sugar produced is the final test. The low yield of the unfertilized plots, although accompanied by a percentage of sugar second only to the plot receiving potash and nitrogen, alone indicates that fertilizers of the nature employed exert a beneficial influence upon this crop. There is some incompatibility in the final results, although generally we may conclude that there is a normal point at which applications of any one element in excess of what the plant naturally uses will be employed with loss. In fact, none of the double applications on plots Nos. 3, 7 and 9 show any appreciable gain over the normal application, plot 5, which is the average of two plots. Leaving out one element entirely in plots 2, 6 and 8 results either in producing a low tonnage of beets on one hand, or a very low percentage of sugar on the other. Some interest is attached to the results from plots 4 and 5 where ammonia nitrogen is compared with nitrate nitrogen. These figures are used in another table found on page 194 where the results of several experiments of this nature are tabulated. From the above we may conclude that it is unsafe to leave out entirely from a given fertilizer any one element, and that it is unwise and unprofitable to apply any particular element in excess. While the experiment does not bring us to any definite formula of mixing the materials employed, it does suggest the use of a certain balanced mixture which may probably be determined by future and more extensive experiments along this line.

Table showing results from applications of maximum, normal and minimum amounts of fertilizing elements on the same soil for three successive years, and averages of the same.

Fertilizers applied.	Amount of each material.	Total.	1899.			1900.			1901.			Average.		
			Yield per acre.	Per cent sugar.	Sugar per acre.	Yield per acre.	Per cent sugar.	Sugar per acre.	Yield per acre.	Per cent sugar.	Sugar per acre.	Yield per acre.	Per cent sugar.	Sugar per acre.
	Lbs.	*Lbs.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*
1. No fertilizer........................	......	....	11,025	10.67	1,176.37	20,840	13.71	2,857.16	12,700	13.33	1,692.91	14,855	12.83	1,908.81
2. No Nitrogen: Nitrate of Soda.................. Dissolved Phosphate Rock .... Muriate of Potash..............	 ...... 400 200	600	12,425	11.26	1,499.06	22,100	12.24	2,704.04	12,820	14.11	1,808.90	15,782	12.69	2,004.00
3. Double Nitrogen: Nitrate of Soda.................. Dissolved Phosphate Rock .... Muriate of Potash..............	 400 400 200	1,000	13,825	10.45	1,444.71	28,440	12.07	3,432.50	18,960	13.24	2,510.30	20,408	12.05	2,462.50
4. Normal Fertilizer: Sulphate Ammonia .... Dissolved Phosphate Rock .... Muriate of Potash..............	 152 400 200	752	14,000	10.77	1,507.80	26,860	12.85	3,451.51	17,300	13.98	2,418.54	19,387	12.68	2,459.18
5. Normal Fertilizer: Nitrate of Soda.................. Dissolved Phosphate Rock .... Muriate of Potash..............	 200 400 200	800	17,877	11.64	2,082.25	26,380	12.27	3,336.89	15,430	13.92	2,148.71	19,895	12.65	2,522.61
6. No Phosphoric Acid: Nitrate of Soda.................. Dissolved Phosphate Rock .... Muriate of Potash..............	 200 200	400	14,525	11.60	1,684.90	20,440	12.58	2,561.35	17,260	14.56	2,513.06	17,408	12.94	2,253.10
7. Double Phosphate Acid: Nitrate of Soda.................. Dissolved Phosphate Rock .... Muriate of Potash..............	 200 800 200	1,200	22,540	11.00	2,479.40	25,600	12.34	3,159.04	17,240	12.63	2,176.41	21,793	11.95	2,604.95
8. No Potash: Nitrate of Soda.................. Dissolved Phosphate Rock .... Muriate of Potash..............	 200 400	600	20,825	11.23	2,338.65	23,420	11.94	2,796.34	17,700	12.65	2,239.05	20,648	11.90	2,458.01
9. Double Potash: Nitrate of Soda.................. Dissolved Phosphate Rock .... Muriate of Potash..............	 200 400 400	1,000	19,250	11.96	2,302.30	26,640	11.43	3,144.95	15,180	13.48	2,046.26	20,357	12.27	2,497.84

Below is the analysis of the fertilizing materials employed in the experiment above and all succeeding fertilizer tests in this bulletin.

Commercial Fertilizer—		
Ammonia		2.24
Phosphoric Acid—		
Available	7.88	
Insoluble	1.04	
Total		8.92
Potash, K_2O		5.67
Nitrate of Soda (95.8 per cent pure), Ammonia		19.16
Sulphate of Ammonia		25.38
Dissolved Phosphate Rock—		
Available	15.64	
Insoluble	.83	
Total		16.47
Muriate of Potash K_2O		54.77
Sulphate of Potash K_2O		49.84

THE EFFECT OF EXCESSIVE AMOUNTS OF FERTILIZING ELEMENTS IN ADDITION TO NORMAL FERTILIZERS.

In line with the preceding experiment was another in field 12 planned to test the effect of excessive amounts of each of the various fertilizing elements in comparison with normal applications in the form of commercial and home mixed fertilizers.

A standard brand of commercial fertilizers was selected and a mixture equal in fertilizing value to 250 pounds was prepared. This required 32 pounds of nitrate of soda, 25 pounds of muriate of potash, and 137 pounds of dissolved phosphate rock. The six plots of the experiment received applications as follows:

Plot 1.—Nothing.
Plot 2.—147 pounds mixture plus 24 pounds nitrate soda.
Plot 3.—147 pounds mixture plus 103 pounds dissolved phosphate rock.
Plot 4.—147 pounds mixture plus 20 pounds muriate of potash.
Plot 5.—195 pounds mixture.
Plot 6.—250 pounds commercial fertilizer.

It will be seen by the above that Plots 2, 3 and 4 received but three-fourths of the mixture as applied to Plot 5: the other fourth being supplied by doubling the amount of nitrogen, phosphoric acid and potash respectively.

The yields of beets, percentage of sugar, and pounds of sugar per acre are given in the table below.

Plot.	Fertilizers.	Yield per acre.	Per cent sugar in beets.	Sugar per acre.
		Pounds.		*Pounds.*
1	Nothing	16,793	15.98	2,709
2	Excessive Nitrogen	25,098	16.23	4,083
3	Excessive Phosphoric Acid	22,843	15.85	3,621
4	Excessive Potash	21,817	15.64	3,412
5	Normal Home Mixture	18,900	17.04	3,220
6	Commercial Fertilizer	17,740	15.66	2,778

These figures show decidedly in favor of increasing the nitrogen content of the sugar beet fertilizers. Not only is the yield of beets greater, but the percentage of sugar is higher where an excessive amount of nitrate of soda is applied. The marked difference in yield of sugar from the home mixed fertilizers over the commercial fertilizer suggests the possibility of nitrate nitrogen being superior to the form of nitrogen found in the commercial fertilizer.

While no experiment comparing in equal quantities organic, nitrate and ammonia nitrogen, the general results so far favor the nitrate.

In the fertilizer experiment on page 198, the nitrogen in the commercial fertilizer analyzing 2.24 per cent ammonia was undoubtedly of organic origin. The results from three years' experiments show a yield of 20 per cent more sugar from nitrate nitrogen than from the commercial fertilizer.

In the soil test experiment on page 196 there was also in comparison a plot treated annually to commercial fertilizer. The average increased yield from the nitrate nitrogen over the organic nitrogen was 18 per cent.

NITRATE NITROGEN VS. AMMONIA NITROGEN.

This experiment has been in progress for three years. The results recorded below are from experiments in three different fields of the College farm. In every case the potash and phosphoric acid applied on the compared plots were identical. The quantity of nitrate of soda and sulphate ammonia was in each case regulated according to the ammonia content of the two materials, so calculated that the same quantity of nitrogen was applied in every case where results are compared.

The following is a fair comparison of nitrate of soda and sulphate ammonia as a source of nitrogen for sugar beets, and being the average result from five different experiments conducted for three years in succession, and showing a yield of over 11 per cent more sugar from the nitrate than from the ammonia presents conclusive evidence of the superiority of the former.

Character of soil.	Nitrate Nitrogen.			Ammonia Nitrogen.		
	Yield per acre.	Per cent sugar.	Sugar per acre.	Yield per acre.	Per cent sugar.	Sugar per acre.
	Pounds.		*Pounds.*	*Pounds.*		*Pounds.*
1. Light sandy	20,408	12.45	2,463	19,387	12.68	2,459
2. Clay loam	20,136	13.19	2,656	16,412	12.44	2,041
3. Sandy loam (complete fertilizer)	16,479	14.09	2,323	15,899	14.19	2,255
4. Same as 3 plus (one ton lime)	18,789	13.43	2,524	15,572	13.19	2,176
5. Sandy loam (as single elements)	15,058	13.29	2,003	13,916	13.19	1,837
Average sugar per acre	....	....	2,394	....	....	2,154

SOIL TEST EXPERIMENTS WITH FERTILIZERS.

The ground on which this experiment was tried has been receiving these applications of fertilizers annually for the past three years, although this is the first year in which sugar beets were sown on this particular portion of the plot. The results of the former experiments were published in Bulletins 179 and 188.

The interesting features of the above table are the high yield from the application of nitrate of soda, the still higher percentage of sugar in the beets from the potash and phosphoric acid plot, and the high tonnage of sugar from the stable manure plot with a correspondingly low percentage of sugar, which brings the final yield of sugar per acre even below that of the mixed mineral plot No. 7 and the complete fertilizer plot No. 8. The experiment was planned with a view to determining the effect of fertilizers upon the sugar content of the product, as well as on the tonnage of the crop. So far as the percentage of sugar from the single elements is concerned, the greater percentage from the application of nitrate of soda as compared with the phosphoric acid and potash plots is something of a surprise. The lower yield of the phosphoric acid plot as compared with the relative yields of the three double element plots is somewhat incompatible, although the percentage of sugar from the double element plot harmonizes with that of the single element plots, except the results from plot 6 where nitrogen and potash are combined in the fertilizer, and the yield of sugar is lower than from either of the single element plots. The effect of the stable manure in giving a comparatively low percentage of sugar, and an excessively high yield in tonnage of beets is in accord with other experiments of this nature. The general conclusion is that for the best results no single element or two element fertilizer will do as well as our complete fertilizers, and that stable manure increases the tonnage but does not increase the total number of pounds of sugar in a similar proportion.

Table showing soil test experiments with fertilizers.

Plot.	Fertilizers.	Pounds of fertilizer per acre.	1899.			1900.			1901.			Average yield of beets for three years.	Average per cent of sugar in beets for three years.	Average yield of sugar per acre for three years.
			Beets per acre.	Per cent sugar in beets.	Sugar per acre.	Beets per acre.	Per cent sugar in beets.	Sugar per acre.	Beets per acre.	Per cent sugar in beets.	Sugar per acre.			
			Pounds.		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*
1	No fertilizer		8,231	11.90	879.48	14,820	12.60	1,867.32	15,212	11.72	1,782.85	12,754	11.83+	1,519.85
2	Nitrate of Soda	120	9,515	12.77	1,215.07	19,075	13.24	2,525.53	20,093	11.75	2,360.60	16,218	12.53+	2,033.74
3	Dissolved Phosphate Rock	240	8,148	12.79	1,042.13	16,188	11.72	1,897.23	16,890	9.23	1,558.95	13,742	10.76+	1,479.63
4	Muriate of Potash	120	10,276	14.44	1,483.85	20,773	12.81	2,661.02	20,821	10.99	2,288.23	17,290	12.40+	2,144.37
5	Nitrate of Soda Dissolved Phosphate Rock	120 240	8,777	12.55	1,101.51	20,440	11.72	2,395.57	24,970	10.64	2,658.81	18,062	11.36+	2,051.96
6	Nitrate of Soda Muriate of Potash	120 120	9,688	13.96	1,352.14	20,300	12.44	2,525.32	25,626	10.38	2,659.98	18,538	11.75+	2,179.15
7	Dissolved Phosphate Rock Muriate of Potash	240 120	9,327	14.43	1,345.89	22,628	13.74	3,109.09	22,278	11.62	2,628.70	18,088	13.06+	2,361.23
8	Nitrate of Soda Dissolved Phosphate Rock Muriate of Potash	120 240 120	11,427	14.00	1,599.78	23,310	13.87	3,233.10	27,227	10.97	2,986,80	20,655	12.61+	2,606.56
9	Stable manure	20 loads	10,802	12.02	1,298.40	27,143	11.42	3,099.73	24,170	10.80	2,610.36	20,705	11.28+	2,336.16

A COMPARISON OF STABLE MANURES WITH OTHER FERTILIZERS.

This experiment has been in progress for three years, the same fertilizers being applied every year. The first seeding in 1901 gave no promise of a complete stand and was harrowed up and reseeded on June 8. The condition of the ground, favorable season for growth of sugar beets, and the excellent care of the field ought to have given a larger yield than was realized in 1901. The only cause than can be offered for the poor growth is the fact that the seed was sown so late. The ground is a sandy loam, very uniform in character, though not typical ground for growing sugar beets. The reader is referred to the comparisons for his conclusions rather than to the yield itself. Here as in soil test experiment referred to on page 196, we find the barnyard manure giving the lowest average per cent of sugar, although the tonnage is nearly the highest. Plot 17 received a dressing of one ton of lime per acre in 1901, while plots 18 to 22 were discontinued after 1900.

The special features of the following table will be brought out by comparisons in smaller tables made from these and others wherein the influence of lime, various forms of nitrogen, and the advantage of home mixed and commercial fertilizers will be more fully explained.

Table showing the effect of air-slaked lime on the growth and sugar content of beets.

Fertilizers.	Unlimed.			Limed.		
	Yield per acre.	Sugar in beets.	Sugar per acre.	Yield per acre.	Sugar in beets.	Sugar per acre.
	Tons.	*Per cent.*	*Pounds.*	*Tons.*	*Per cent.*	*Pounds.*
Average 3 nothing plots	7.00	13.79	1,930	7.45	13.45	2,003
Commercial fertilizer	7.15	13.67	1,945	8.09	13.04	2,111
Home mixed fertilizer (Nitrate Nitrogen)	8.24	14.09	2,323	9.39	13.43	2,524
Home mixed fertilizer (Ammonia Nitrogen)	7 95	14.19	2,255	7.79	13.19	2,176
Totals	30.34	....	8,453	32.72	....	8,814
Average	7.59	13.93	2,113	8.18	13.28	2,204
In favor of lime, tons of beets				.59	....	....
In favor of lime, pounds of sugar per acre				....	....	91

The unlimed plots in every case produced beets richer in sugar.

Woll in Wisconsin Experiment Station Bulletin No. 71 found that lime increased the percentage of sugar in six cases, and decreased it in two, but that there was no difference in the average results in favor of lime.

Table showing comparison of stable manures with other fertilizers.

Plot No.	Fertilizers.	Amount per acre.	1899.			1900.			1901.			Average for three years.	Average per cent.	Average sugar for three years.
			Yield of beets per acre.	Per cent sugar in beets.	Yield of sugar per acre.	Yield of beets per acre.	Per cent sugar in beets.	Yield of sugar per acre.	Yield of beets per acre.	Per cent sugar in beets.	Yield of sugar per acre.			
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*
1	Barnyard manure........	20 loads	14,310	13.15	1,881.77	27,660	10.80	2,987.28	14,251	13.70	1,952.38	18,740	12.30	2,273.81
2	Sugar beet fertilizer......	480	12,560	14.00	1,758.40	18,840	12.63	2,379.49	11,374	15.02	1,708.38	14,291	13.67	1,945.43
3	Sugar beet fertilizer...... Air-slaked lime...........	480 1 ton	14,350	13.18	1,891.33	21,060	11.61	2,444.97	13,153	15.17	1,995.31	16,188	13.04	2,110.54
4	No fertilizer.............	....	16,510	14.01	2,313.08	18,640	13.01	2,425.06	11,199	14.87	1,662.59	15,450	13.80	2,133.58
[*]5	Complete fertilizer (Nitrate Nitrogen).........	480	15,630	14.08	2,200.70	20,540	13.83	2,840.68	13,267	14.53	1,927.70	16,479	14.09	2,323.03
[*]6	Complete fertilizer (Nitrate Nitrogen.......... Air-slaked lime...........	480 1 ton	17,750	14.24	2.527.60	23,180	12.14	2,814.52	15,434	14.45	2,230.21	18,789	13.43	2,524.11
[†]7	Complete fertilizer (Ammonia Nitrogen)........	455	15,000	13.89	2,083.50	20,260	14.06	2,848.56	12,436	14.75	1,834.31	15,899	14.19	2,255.46
[†]8	Complete fertilizer (Ammonia Nitrogen).......... Air-slaked lime...........	455 1 ton	14,630	14.52	2,124.28	19,420	12.84	2,493.53	12,665	15.08	1,909.82	15,572	13.19	2,175.88
9	No fertilizer.............	....	12,870	13.79	1,774.77	16,360	13.18	2,071.18	10,137	15.43	1,564.14	13,122	13.74	1,803.36
10	Dissolv'd Phosphate Rock Muriate of Potash........	250 250	16,330	13.57	2,215.98	19,520	11.32	2,209.66	13,792	13.67	1,905.37	16,547	12.77	2,110.34
11	Nitrate of Soda...........	250	13,680	14.11	1,931.05	19,300	12.24	2,362.32	12,194	14.88	1,714.47	15,058	13 29	2,002.61
12	Sulphate of Ammonia....	190	13,620	12.86	1,751.53	17,360	12.66	2,197.78	10,767	14.50	1,561.22	13,916	13.19	1,836.84
13	Air-slaked lime...........	1 ton	14,960	13.99	2,092.90	18,000	12.47	2,244.60	11,715	14.27	1,671.73	14,892	13.45	2,003.08
14	No fertilizer............	....	13,660	13.96	1,906.94	16,460	13.27	2,184.24	10,059	14.57	1,465.60	13,393	13.83	1,852.26
15	Dissolv'd Phosphate Rock Muriate of Potash........	250 250	14,440	14.83	2,141.45	17,580	14.19	2,494.60	11,539	14.75	1,702.00	14,520	14.52	2,112 68
16	Sulphate of Potash.......	250	14,070	13.24	1,862.87	18,020	12.16	2,191.23	10,869	15.08	1,639.05	14,320	13.25	1,897.72
17	Hen manure (top dressing)	....	13,260	14.08	1,867.01	21,080	12.24	2,580.19	12,204	13.67	1,668.29	15,515	13.14	2,038.46
18	No fertilizer.............	....	11,300	14.00	1,582.00	16,620	12.52	2,080.82	....	....	....	13,960	12.40	1,831.41
19	Wood ashes...............	2,000	12,000	13.22	1,586.40	19,120	13.27	2,537.22	....	....	....	15,560	13.25	2,061.81
20	Sugar beet home mixture	500	11,900	14.67	1,745.73	18,460	12.26	2,263.20	....	....	....	15,180	13.20	2,004.47
21	Sugar beet fertilizer, commercial......	500	10,280	13.42	1,379.58	17,580	13.42	2,359.24	....	....	....	13,930	13.42	1,869.41
22	Salt.......................	2,000	13,950	12.63	1,751.89	19,080	13.11	2,491.39	....	....	....	16,515	12.84	2,121.64

[*] Plots 5 and 6 received in Nitrate of Soda 50 pounds, Dissolved Phosphate Rock 220 pounds, and Muriate of Potash 42½ pounds.
[†] Plots 7 and 8 received in Sulphate of Ammonia 40 pounds, Dissolved Phosphate Rock 220 pounds, and Muriate of Potash 42½ pounds.
These mixtures equal in fertilizing value to the commercial fertilizer on plots 2 and 3.

EXHAUSTIVE EFFECTS OF THE SUGAR BEET CROP.

Below is a table showing the difference in the average of three unfertilized plots for three years with three similar plots for the same period which were treated with a normal application of fertilizers. The object of making this comparison is to show the importance of giving some return to the land in payment for the beet crop. The mistake of comparing yields one year with another is here at once apparent, for it will be noticed that even the unfertilized plot in 1900 gave larger yield than the fertilized plot of 1899. Then the sudden drop in 1901 due largely to the lateness of the season at which the seed was planted and the other climatic conditions prevailing that year is further proof that comparisons can only be made all in one season and where conditions are analogous.

	1899.		1900.		1901.	
	No fertilizer.	Fertilizer.	No fertilizer.	Fertilizer.	No fertilizer.	Fertilizer.
Pounds of sugar per acre.......	1,998.26	2,023.74	2,226.82	2,506.38	1,564.11	1,815 73
Differences—						
In favor of fertilizers.........	....	25.48	....	279.56	....	251.62
Per cent of difference—						
In favor of fertilizers.........	....	1.25	....	11.25	....	13.85

The relative decrease in yield of the unfertilized plots as compared with those receiving annually an application of fertilizer increases as the experiment progresses, it being but 1.25 per cent the first year, 11.25 per cent the second year, and 13.85 per cent the third year. The exhaustive quality of the sugar beet crop was brought out to some extent in Bulletin No. 188, page 101, where it was shown that neither beans nor potatoes were so exhaustive as were the sugar beets. Observations on the growth of a corn crop in one of the College fields the past year where one end of the field had been sown the previous year to sugar beets and the other to cow peas showed a marked difference in the growth of the corn. At the time first tasseling the corn on the cow pea ground was fully one foot taller than on the ground which previously had grown sugar beets, and the tasseling was fully a week in advance. A similar observation was made on two strips of corn in another field, one-half of which had grown on sugar beet ground the year previous, and the other half upon potato ground. There was a marked difference in the appearance of the two plots, decidedly in favor of the potato ground. Owing to the imperfect germination of the seed corn the yields of the two strips were too irregular to admit of comparison.

DATE OF SAMPLING OF SUGAR BEETS.

The accompanying table shows the results of analyses of beets sampled between September 11 and November 16, from plantings of various dates. The latter named date being practically the end of the season for harvesting beets. While no definite conclusions can be drawn from this table, a study of the following table showing the temperature and rainfall of the period during which the beets were being sampled, shows some interesting relations existing between the dates of heaviest rainfall and the rise and

Results of analysis of sugar beets from plantings made weekly from April 13 to June together with weekly

Date plant'd	April 13.				April 24.				May 1.				May 8.			
Date sampl'd	Av. Wt. Oz.	Purity.	Percent sugar.		Av. Wt. Oz.	Purity.	Percent sugar.		Av. Wt. Oz.	Purity.	Percent sugar.		Av. Wt. Oz.	Purity.	Percent sugar.	
Sept. 11	12	75.8	10.40	10.42	10	81.4	10.58	10.25	8	79.7	11.29	10.86	10	83.0	12.30	11.83
" 13	17	81.4	10.45		13	77.1	9.92		11	80.2	10.43		12	79.5	11.37	
" 16	11	74.4	7.62	9.17	12	79.7	10.84	9.44	11	80.9	10.12	10.70	8½	80.9	11.28	11.77
" 18	11	78.8	10.97		8	78.9	8.13		11	82.8	10.40		11	82.1	12.24	
" 20	13½	78.2	8.91		12½	76.7	9.34		9	80.7	11.47		13	81.0	11.78	
" 23	10	75.5	10.02	9.80	12	80.8	10.07	10.84	12	81.4	10.89	11.10	11	78.3	10.34	11.71
" 25	8	80.1	8.96		9	81.3	11.34		8	76.9	10.35		16½	82.6	11.80	
" 27	10	78.5	9.42		11	82.3	11.11		7	81.8	12.07		9	83.4	13.00	
" 30	12	79.3	10.53	10.64	10	83.2	11.45	10.85	9	85.3	13.34	11.67	8	84.2	13.21	12.59
Oct. 2	9	82.4	10.53		10	82.9	11.62		8	80.6	11.45		8	82.4	12.49	
" 4	11	80.3	10.86		15	76.9	9.47		8	84.7	10.29		9	86.2	12.06	
" 7	10	75.0	9.65	9.70	11	80.8	11.19	11.00	8	81.4	12.07	11.01	12	85.7	12.66	13.03
" 9	10	79.7	10.83		7½	80.5	10.19		8	79.4	10.70		9	86.9	12.79	
" 11	14	75.5	8.52		9	85.3	11.62		9	83.2	10.26		11	84.1	13.63	
" 14	19	78.8	9.92	10.54	22	75.6	8.59	10.22	11	73.8	9.65	11.07	9	81.6	11.43	11.88
" 16	14	80.8	10.40		8	76.5	10.50		8	83.7	11.47		9	84.1	11.81	
" 18	15	75.4	11.31		13	79.7	11.58		9	78.9	12.09		9	84.9	12.39	
" 21	13	73.1	10.63	9.74	14	76.3	11.35	11.20	7	82.4	10.00	10.54	7	84.9	14.48	14.12
" 23	14	76.7	9.37		12	84.0	11.72		8½	80.3	11.21		9	90.5	13.96	
" 25	11½	74.6	9.23		12	81.4	10.52		8	79.6	10.40		10	86.3	13.93	
" 28	11½	80.9	12.01	11.60	12	84.3	12.31	11.81	9	85.0	11.99	11.58	8	85.2	14.24	14.27
" 30	10	83.3	12.42		10	83.5	12.63		9	80.4	10.94		9	85.9	14.56	
Nov. 1	9	76.4	10.38		14	79.2	10.50		9	84.4	11.80		10	84.9	14.00	
" 4	15	81.4	11.72	12.03	11	83.8	12.39	12.33	12	89.0	12.68	12.89	9½	88.3	13.20	13.94
" 7	11	78.3	11.97		15	83.9	12.47		9	83.3	13.80		8½	84.0	14.55	
" 8	10	79.3	12.39		11½	79.0	12.14		11	79.7	12.19		7	81.0	14.07	
" 11	15	73.9	9.85	11.56	10	83.3	11.98	11.96	7	83.7	12.24	12.50	9	80.5	12.87	12.46
" 13	12	78.4	11.73		9	84.9	12.97		10	84.4	12.42		11	83.2	11.86	
" 16	12	85.0	13.10		13	76.8	10.94		7	79.5	12.83		10	79.5	12.54	

fall in the percentage of sugar. For instance, the low line of figures indicated during the weeks from October 14 to 25 were probably caused by the heavy rains and accompanying cloudy weather of that period. The low percentage of sugar of the earlier planted beets is evidence of reference made on page 188 to the statement that these early planted beets were most affected by the leaf blight. It will be seen from this table that the first week in November shows the highest percentage of sugar in the beets. Departing from this date either way, shows a gradual decrease though weather conditions modify somewhat this general statement.

Armsby and Hesse in Pennsylvania Experiment Station Bulletin No. 47 found that, 139 samples harvested before November 1 yielded 11.48 per cent sugar, while 82 samples harvested after November 1 averaged 13.18 per cent sugar.

5 inclusive, and sampled on alternative days from September 11 to November 16, averages of the same.

May 15.				May 22.				May 29.				June 5.			
Av. Wt. Oz.	Purity.	Per cent sugar.		Av. Wt. Oz.	Purity.	Per cent sugar.		Av. Wt. Oz.	Purity.	Per cent sugar.		Av. Wt. Oz.	Purity.	Per cent sugar.	
8	84.2	11.23	11.53	15	82.5	12.30	11.87	11	80.3	11.15	11.20	11	80.1	11.72	11.45
9	82.7	11.84		14	81.1	11.45		9	79.2	11.25		12	79.2	11.18	
9	78.7	10.84	11.38	14	86.3	12.66	12.08	9	81.5	12.11	11.83	10	78.5	9.77	9.99
11	85.5	11.94		10½	85.1	12.09		10	83.1	12.26		12	83.2	10.26	
8	84.7	11.37		14	84.3	11.50		11	80.7	11.13		14½	81.2	9.95	
8½	82.3	11.58	11.79	13	84.9	11.23	11.72	8	82.8	11.91	12.36	8	83.7	11.58	11.51
9	85.0	11.94		7	87.0	12.34		9	83.2	12.78		11	81.3	11.55	
10½	81.1	11.86		11	83.4	11.60		9½	81.8	12.39		10	80.0	11.40	
9	87.8	13.25	12.32	9½	84.6	12.11	11.03	10	84.4	12.97	12.18	9	84.4	12.42	11.88
7	80.4	11.68		15	80.7	9.77		10	85.0	11.99		11	86.7	11.99	
13	79.9	12.04		9	83.4	11.21		13½	80.8	11.58		10	80.3	11.23	
9½	81.1	11.83	12.30	13½	88.4	12.58	12.92	7	81.0	12.11	12.00	9	86.9	12.21	11.81
9	82.9	12.09		5	88.2	13.77		12	80.9	11.70		11	82.9	11.60	
9½	85.9	12.37		8½	83.3	12.42		12	81.5	12.19		10	81.8	11.62	
8	80.9	11.70	11.82	17	80.4	11.34	11.26	7	84.8	12.29	12.32	7	83.1	11.99	11.35
7½	84.1	11.63		16	75.5	10.70		9	87.4	12.19		12	78.8	10.63	
11	86.8	12.13		14	80.0	11.75		9	86.7	12.58		10½	80.5	11.42	
11	82.6	11.29	12.22	12½	85.5	13.62	13.77	12	80.1	12.60	12.10	9	82.6	12.24	12.10
10	82.7	13.27		11	89.4	14.00		11	81.4	12.09		8	85.0	12.55	
11	80.5	12.11		9½	86.6	13.68		11	77.8	11.62		10	82.7	12.40	
10	81.9	12.54	12.77	10	88.2	14.10	12.96	11	83.4	13.00	12.63	8	84.1	11.80	12.45
9½	83.7	12.29		8	82.7	12.32		8	82.7	11.86		12	78.8	12.29	
8	83.3	13.37		13½	84.4	12.47		11	84.3	13.03		9½	82.7	13.25	
9	81.9	13.10	14.22	9	86.2	13.20	13.39	11	84.1	12.11	13.44	11	82.9	11.57	12.43
7	86.0	14.72		7	83.7	13.73		9	81.0	14.58		9	80.2	13.43	
9	85.1	14.74		11	81.4	13.25		10	88.6	13.64		9	78.2	12.28	
9	76.4	11.78	11.41	8½	81.0	13.29	12.53	12	81.3	13.10	12.73	9	77.2	11.78	12.33
10	77.3	11.50		11	80.3	11.37		11	80.1	12.97		9	81.7	13.14	
9	74.8	10.94		11	81.0	12.93		11½	82.0	12.12		9	83.4	12.06	

Table showing temperature, amount of rainfall and per cent of clouds between April 1 and December 1, 1901.

Day of month.	April, 1901.			May.			June.			July.			August.			September.			October.			November.		
	Temp.	Rainfall.	Clouds, %	Temp.	Rainfall.	Clouds, %	Temp.	Rainfall.	Clouds, %	Temp.	Rainfall.	Clouds, %	Temp.	Rainfall.	Clouds, %	Temp.	Rainfall.	Clouds, %	Temp.	Rainfall.	Clouds, %	Temp.	Rainfall.	Clouds, %
1	42⅔	......	00	65⅔	......	60	49	.40	100	85	......	00	62⅔	......	25	62⅔	......	50	66⅓	.02	15	43⅓	......	00
2	36⅔	......	100	66⅓	......	10	51⅔	.02	60	83	......	00	69⅓	.14	55	66⅔	......	60	48	.03	70	44⅓	......	00
3	36⅓	......	100	51⅓	......	00	58⅔	......	00	79⅓	.04	15	65⅓	......	80	69	......	00	40⅔	......	15	45⅓	.13	50
4	47⅓	......	00	59⅓	......	05	68	......	00	80	.25	52½	62⅓	......	05	71⅓	......	00	40	......	25	25⅔	.05	90
5	46⅓	......	50	65⅓	......	15	75⅓	.10	20	79	2.16	10	65⅓	......	05	74⅔	......	00	47⅓	......	00	28⅓	......	75
6	39⅓	.26	100	64⅔	......	85	65⅓	......	100	72	......	05	68	......	20	73⅔	......	10	44⅔	......	00	38⅓	......	35
7	43⅓	......	70	61⅔	.01	75	51⅔	......	70	59⅔	......	100	71⅔	......	25	73⅓	.08	15	60⅔	......	00	39	......	100
8	40⅔	......	95	58⅔	.69	95	51	......	10	64⅓	......	15	66⅓	......	17.5	57	......	80	63⅓	......	45	38⅓	......	25
9	46	......	00	58⅔	.24	100	57⅓	......	00	72⅔	.14	100	69⅔	......	95	55⅓	.20	100	61	.60	65	34⅔	......	55
10	43	......	00	61	......	85	65	.21	55	81⅔	......	00	66⅔	......	85	61⅔	.01	100	54⅓	.30	90	35⅓	......	20
11	44⅔	......	00	53⅔	.16	55	71	.32	80	72	......	05	61	......	25	61	.88	100	63⅔	......	25	53⅔	.51	100
12	47	......	10	40⅔	.14	80	80⅓	......	15	70⅓	......	05	66⅓	......	05	76⅓	.28	55	53⅔	3.02	100	37⅔	......	100
13	51	......	75	47	......	20	74⅓	.86	70	73⅓	......	00	67⅓	......	10	61⅓	......	00	46	.56	65	36⅓	......	45
14	47⅔	......	80	46⅓	......	15	72⅔	.24	65	79⅓	......	05	75⅓	......	05	65⅔	.11	25	46⅓	......	30	40⅔	.03	30
15	50⅓	.01	80	53⅔	......	00	66⅓	......	80	80⅓	.14	45	72⅔	......	50	77⅓	......	70	51⅔	......	30	31	......	80
16	54⅔	.20	40	62	......	00	69	......	85	80⅔	......	50	69⅔	......	10	61	......	15	44⅔	......	100	30⅔	......	75
17	50⅓	......	100	65⅓	.07	70	67⅓	......	80	81	......	00	75⅔	......	30	52	......	45	37⅓	......	30	33⅔	......	100
18	33⅔	.82	100	59⅔	......	20	70⅓	.23	15	77⅔	......	00	74⅓	.42	95	45⅓	.10	60	46	......	35	32	.02	55
19	35⅓	......	45	52⅓	.02	100	68⅓	.07	15	73⅓	......	00	69⅓	.06	100	47⅔	.02	50	49⅔	......	00	33⅓	......	100
20	38⅓	......	30	53⅔	......	80	68	......	35	79⅓	......	00	69⅓	......	100	47⅓	......	90	41⅔	......	00	30⅓	......	45
21	36⅓	......	100	56⅔	.29	100	70⅓	.02	35	81	......	65	76	......	60	54⅔	......	35	52⅓	......	00	34⅓	......	00
22	45	.67	100	59⅓	......	75	74⅔	......	55	79⅓	......	00	74⅔	.32	45	64⅓	......	00	60⅓	......	00	37⅔	......	100
23	51	.12	65	67⅓	.70	15	72⅓	......	15	78⅓	.26	00	71⅓	......	75	67⅓	......	00	61⅓	......	15	33⅓	.43	100
24	53⅔	.08	50	53⅔	......	100	78	......	00	79⅓	.04	05	70⅓	......	05	62⅔	......	00	40⅔	......	15	33	.04	100
25	55	......	10	50	......	85	79⅓	.69	25	78	1.38	65	71	......	20	58⅔	......	45	41⅔	......	00	30⅓	......	100
26	61	......	00	47⅔	.02	100	80⅓	......	10	70⅔	.04	80	68	.57	100	67⅔	......	00	54⅔	......	35	25⅔	......	65
27	60⅔	......	00	55⅔	......	70	82⅔	......	00	81	.01	30	71⅓	......	00	69	......	00	41	......	05	23⅔	......	65
28	60⅔	......	00	50⅔	......	50	80	.18	40	82	......	25	74⅔	......	00	65⅓	......	30	44⅔	......	40	24⅔	......	35
29	65⅔	......	00	51	.02	60	74⅔	.23	05	74	.62	100	74⅔	......	30	64	......	80	61⅔	......	20	36⅔	......	100
30	69⅓	......	30	49⅓	......	60	78⅓	......	45	72	......	06	67⅓	.98	20	56	......	15	63	......	10	35	......	55
31	......	......	......	52⅓	......	100	......	......	......	67⅓	......	25	60⅓	......	90	......	......	......	57⅓	.08	60	......	......	......
Total	......	2.16	......	......	2.36	......	......	3.57	......	......	5.08	......	......	2.49	......	......	1.68	......	......	4.61	......	......	1.21	......
Mean temp	47.78	......	......	57.42	......	......	69.04	......	......	76.32	......	......	69.27	......	......	62.67	......	......	51.13	......	......	34.53	......	......

SHRINKAGE OF STORED BEETS.

To test the effect of storing beets in piles in the field, six varieties which were harvested October 26 from sandy loam soil were on that date carefully weighed, sampled, the entire amounts of each variety ranging from 800 to 1,000 pounds stored in single piles, and covered with beet leaves. On November 27 they were forked into wagons, again weighed and sampled, and returned to the field for storage as before until December 31. During the last four weeks of this period the beets were covered with the beet leaves, but as the leaves had become so wilted as to scarcely cover the piles, a covering of four to six inches of clover straw was thrown on and this covered with a layer of soil about five inches thick. At the time the soil was put on the piles, the beets were slightly frozen on the outside, though not to any considerable depth. When the beets were removed from the piles for the last time on December 31, they were found to be in perfect condition. The soil covering them, was frozen so that it required a pick to remove it, but the beets were not frozen at all, the frost having apparently been drawn out of them during the storage. The weights, analysis and percentages of gain and loss for the several periods are given in the following tables.

Tables showing the shrinkage in weights of sugar beets and changes in sugar content during nine weeks' storage in piles with sufficient protection to prevent freezing.

Variety.	Weights.			Loss in weight.		
	Oct. 26.	Nov. 27.	Dec. 31.	Per cent of loss first month.	Per cent of loss second month.	Total per cent of loss.
	Pounds.	*Pounds.*	*Pounds.*			
Austrian B. A.	817	685	657	16.15	4.08	19.58
Austrian B. G. V.	867	745	722	14.07	3.08	16.72
Russian W. A. C.	875	750	730	14.02	2.66	16.57
Meyers' Elite	930	810	790	12.90	2.49	15.05
Wohanka E. R.	845	770	725	8.87	5.84	14.02
Wohanka Z. R.	1,011	895	854	11.47	4.53	15.52
Grand total and averages	5,345	4,655	4,478	*12.91	*3.80	*16.22

Variety.	Per cent of sugar.					
	Oct. 26.	Nov. 27.	Dec. 31.	Per cent + gain or — loss first month.	Per cent + gain or — loss second month.	Total per cent + gain or — loss.
Austrian B. A.	12.79	14.07	13.20	+10.00	—6.11	+3.2
Austrian B. G. V.	10.97	14.99	12.60	+36.64	—15.94	+14.85
Russian W. A. C.	11.18	15.09	12.50	+34.97	—17.16	+11.80
Meyers' Elite	9.67	13.61	11.60	+40.74	—14.76	+19.95
Wohanka E. R.	11.67	15.18	9.10	+30.08	—40.05	—22.02
Wohanka Z. R.	10.14	14.80	12.50	+45.95	—15.54	+23.27
Averages	11.24	14.62	11.92	*+30.00	*—19.00	*+6.00

* Computed from averages and not from figures above.

Table showing changes in co-efficient of purity and pounds of sugar during nine weeks' storage in piles with sufficient protection to prevent freezing.

Variety.	Purity.			Per cent gained or lost.		
	Oct. 26.	Nov. 27.	Dec. 31.			
Austrian B. A.	80.8	80.5	74			
Austrian B. G. V.	73.3	80.0	74			
Russian W. A. C.	80.3	84.5	75			
Meyers' Elite	75.6	77.1	71			
Wohanka E. R.	83.5	80.9	63			
Wohanka Z. R.	75.4	78.1	74			
Averages	78.0	80.0	72	*+2.56	*—10.00	*—7.7

Variety.	Pounds of sugar.			Per cent gained or lost.		
	Oct. 26.	Nov. 27.	Dec. 31.	First month.	Second month.	Total.
Austrian B. A.	104.49	96.38	86.72	—7.76	—10.95	—17.00
Austrian B. G. V.	95.11	111.67	90.97	+17.41	—18.53	—4.35
Russian W. A. C.	97.83	103.18	91.25	+5.46	—11.56	—6.72
Meyers' Elite	89.93	110.24	91.64	+22.58	—16.87	+1.90
Wohanka E. R.	98.61	116.89	65.98	+18.53	—43.55	—33.08
Wohanka Z. R.	102.52	132.46	106.75	+29.39	—19.40	+4.12
Total and average per cent	588.49	670.82	533.31	*+13.99	*—20.49	*—9.37

*Computed from averages and not from figures above.

Considering the loss in weights, the excessive decrease from October 26 to November 27 is due in part to the dirt which was still clinging to the beets when they were first weighed; although they were carefully trimmed, and but little dirt was on them. It is quite likely that the percentage of evaporation for this period was very much more than for the second period. It will be observed, however, that the decrease in weight was not commensurate with the increase in the per cent of sugar, for, under the table of pounds of sugar, it will be seen from these figures that there was an actual increase of 82⅓ pounds of sugar, or practically 14 per cent. During the second month it will be seen that there was but a slight shrinkage in the number of pounds of beets, and some of this may have been due to the dirt which rattled off. In the beets, however, there was a change going on as shown by the decrease in the per cent of sugar, giving for the final loss in pounds of sugar 9.37 per cent. The coefficient of purity shows a slight increase during the first month, but a marked decrease during the second month, averaging about 78 in the first test, 80 in the second, and 72 in the third.

Whether or not there is actually a development of sugar in the beet which continues for a short period after it is harvested, and whether the best time to secure the greatest amount of sugar follows within three or four weeks from the time the beets are harvested, are problems that this experiment opens up. That the coefficient of purity should behave practically as it did in this case is in accord with other experiments noted in this connection. It was to be expected too that the per cent of sugar would increase practically in proportion to the decrease in weight of the beets by evaporation, but so marked a change, resulting in an increase of practically 14 per cent in the actual sugar in the beets, is indeed a surprise. Should it, upon further experiment, be determined that storing beets for a period of nine weeks will result in a loss of nearly 10 per cent in the money value of the crop, it certainly presents a question demanding serious consideration, and the devising of plans to either convert the beets more promptly into sugar or so store them as to prevent this loss.

In Colorado Experiment Station Bulletin No. 46, the conclusion is that "Simple freezing does not affect the quality of the beets, while drying out increases the percentage of sugar, but is accompanied by an actual loss of sugar." In Bulletin No. 58 of the same experiment station it is discovered that if fresh beets be soaked for seven days in water cooled by ice, an actual increase of sugar takes place, indicating the formation of sugar in the beet root. While the former conclusion of the Colorado experiments are somewhat contradictory to ours, the latter statement relative to the formation of sugar in the beet root may be a condition somewhat analogous to the development of sugar in stored beets during cold weather when the temperature conditions would be analogous to that of soaking in ice water.

MISCELLANEOUS EXPERIMENTS.

VITALITY OF OLD SEED.

This experiment was conducted by employing seeds which have been accumulating for the last four years in the experiment station seed room. Seeds four years, three years, two years and one year old were compared in adjacent rows. There was practically no difference in the vitality of the seeds, as the plants of all appeared above ground on exactly the same date. The newest seed, that is, seed purchased the year of the experiment, showed a weaker growth than any of the other varieties, although every lot gave a perfect stand. These seeds had been kept in a perfectly dry room in the sacks in which they were shipped. The result of this experiment indicated that keeping sugar beet seeds under favorable conditions does not injure them.

SOAKING SEED.

In connection with the above experiment each of the lots of seed of different ages was soaked in pure water for 24 hours prior to sowing. The results show no advantage from this practice, while the inconvenience of sowing the moistened seed was a hindrance. The fact that the seed was moist interfered with the perfect action of the seed drill to such an extent than an uneven growth was obtained where the soaked seeds were planted.

HOME GROWN SEED.

In the year 1900 a few sugar beet seed were grown with a view to study the question of producing our own seed. This experiment met with fair success, a small crop of seed being produced that year, the same being planted in the spring of 1901. The beets from this planting are now in storage to be tested and replanted the coming season. The results so far demonstrate the possibility of growing sugar beet seed in this locality. The development of this branch of the industry, will require years of careful work, but it suggests a line of experiment which calls for further and careful attention. From the plants which produced seed in the fall of 1900 a few seeds were scattered on the ground. They lived through the winter and came on the following spring giving a substantial growth of beets of good size, which, harvested September 7, 9 and 11, gave average yields of 10.77 per cent of sugar from beets averaging 17 ounces in weight. Other beets weighing 10 ounces each from adjacent plots sown early in the spring yielded from 9.7 per cent to 12 per cent sugar. The possibility of seeding to sugar beets in the fall is being tested by further experiment from seedings made in October, 1901. The result of this accidental experiment in fall seeding point to a new possibility in the management of the sugar beet crop. We produced beets of larger size and with a satisfactory percentage of sugar, and could this method of planting be practiced, it would be a great help in distributing the work of thinning the beets and caring for the crop.

COMMERCIAL SEED.

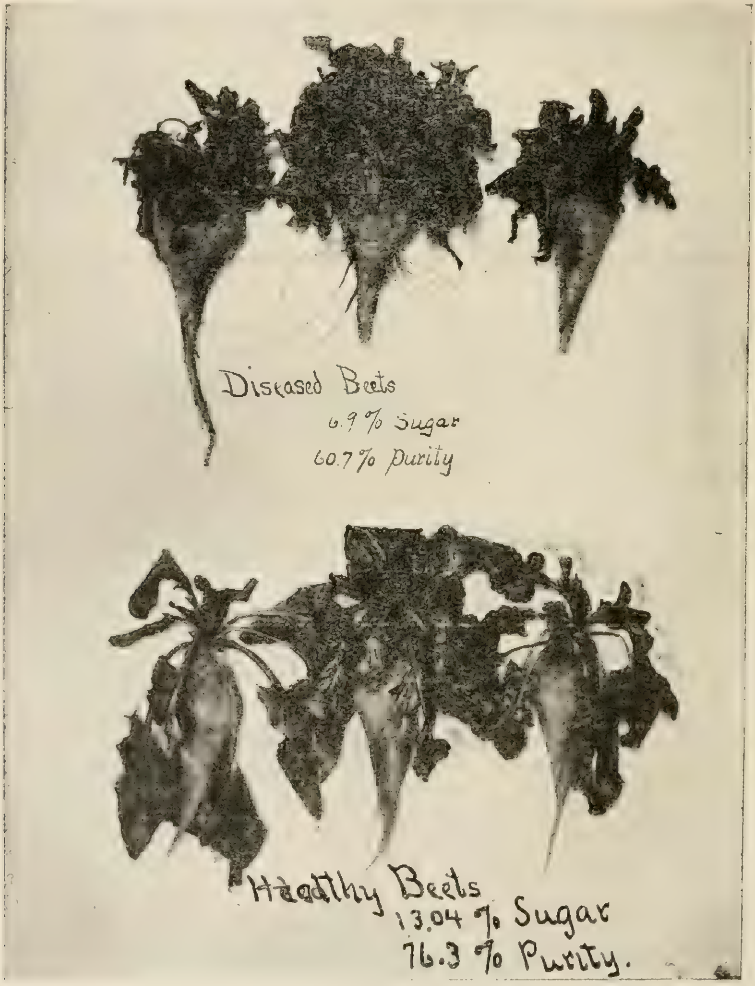
All the wholesale farm and garden seed dealers offer sugar beet seed for sale. A trial of two varieties bought of a prominent seedsman produced beets as follows:

Kleinwanzlebener	9.11 per cent sugar, 71.8 purity.
Vilmorin	10.96 per cent sugar, 74.0 purity.

Eight varieties of imported seed on adjacent ground harvested on the same date averaged 12 per cent sugar and 79 per cent purity.

LEAF CURL OF BEETS.

This is a condition appearing at irregular intervals in a field of bets showing a deadened condition of the old leaves and a growth of sickly leaves resembling the condition of leaf curl of the peach. The condition is not uniform, nor is there any particular condition of soil so far as we have noticed by which it can be located. From examination of fields where the beets have been grown continuously for four years as compared with new land on which beets were growing this season for the first time, there seems to be little difference in the frequency of appearance of this disease. Neither did one variety of seed, or seed from any particular source show it more than others. From numerous observations it is found to appear on from one to three beets in one hundred.



Some very late planted beets, however, averaged but one diseased beet in two hundred. It is very seldom that two beets adjacent to each other in the row are affected. The leaves on the crown of the beet seem to have entirely died, but the new growth of curled leaves grew in numerous heads, each resmbling a crown of leaves of a small beet, while in some cases there is but one central leaf bunch. In the more advanced stage there are many small bunches numbering as high as thirty on a single beet and varying in size from a tiny four leaf head to one inch in diameter. These bunches of leaves are easily broken off. Where there is a single cluster of leaves the crown is considerably elongated, and as a rule the crown covered with small clusters of leaves is abnormally developed. In either case it is evident that the development of the plant has been directed to the repair of an injury caused by some insect or bacterial or fungous enemy rather than to the storing up of sugar in its root. Several tests of diseased beets were made. In every case the analysis showed a very low per cent of sugar ranging from 5 to 7½ per cent. While this disease is not of sufficient prominence to cause any serious alarm, it is evident that the presence of one or two beets thus affected as in the sample analyzed, might seriously lower the percentage of sugar in the sample. The cut on page 206 shows three diseased beets above and three healthy beets below. In each case a healthy beet was taken beside a diseased beet in the same row. It is barely possible that it might be wise to discard all beets affected with this disease.

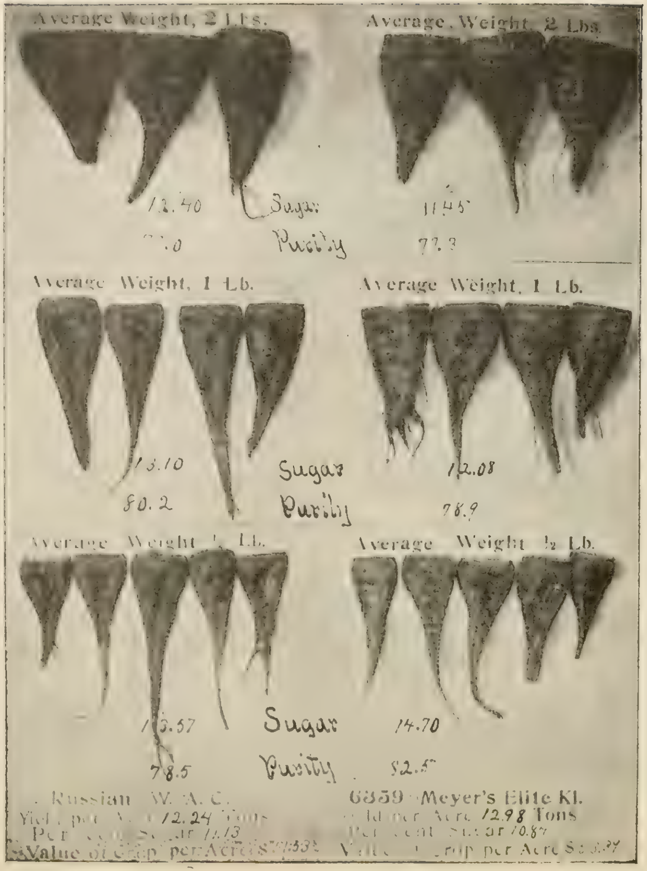
THE INFLUENCE OF SIZE OF BEETS ON SUGAR CONTENT.

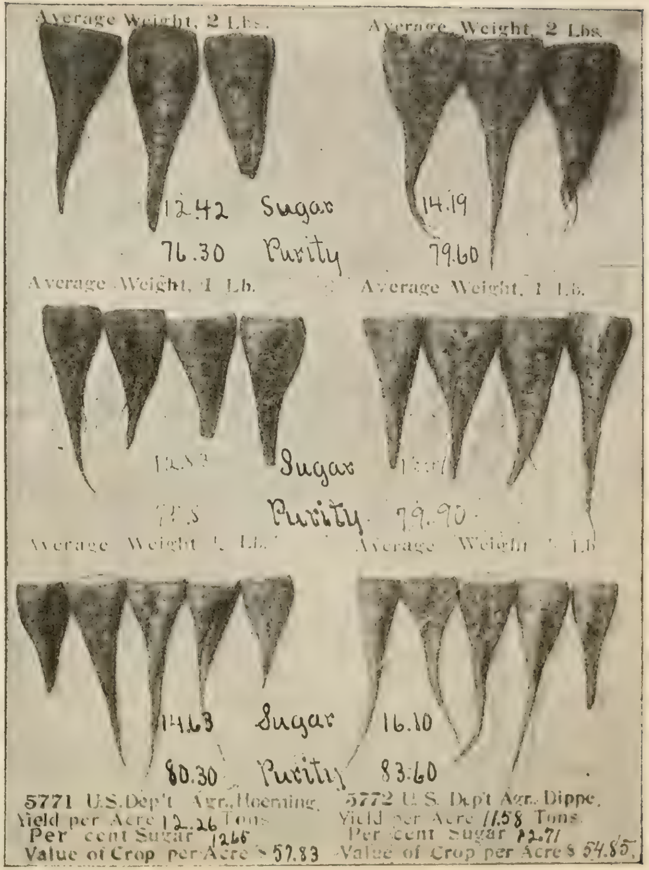
As illustrating the influence of the size of beets upon the sugar content, the cuts on pages 208 and 209 represent the beets, analyses of which are in the following table. It will be seen in this table that in every case except one the percentage of sugar in each variety increases as the size decreases. While the average difference between a 32 ounce and 8 ounce beet is two per cent, the 16 ounce beet being richer in sugar by nearly two- thirds of a per cent than the 32 ounce beets.

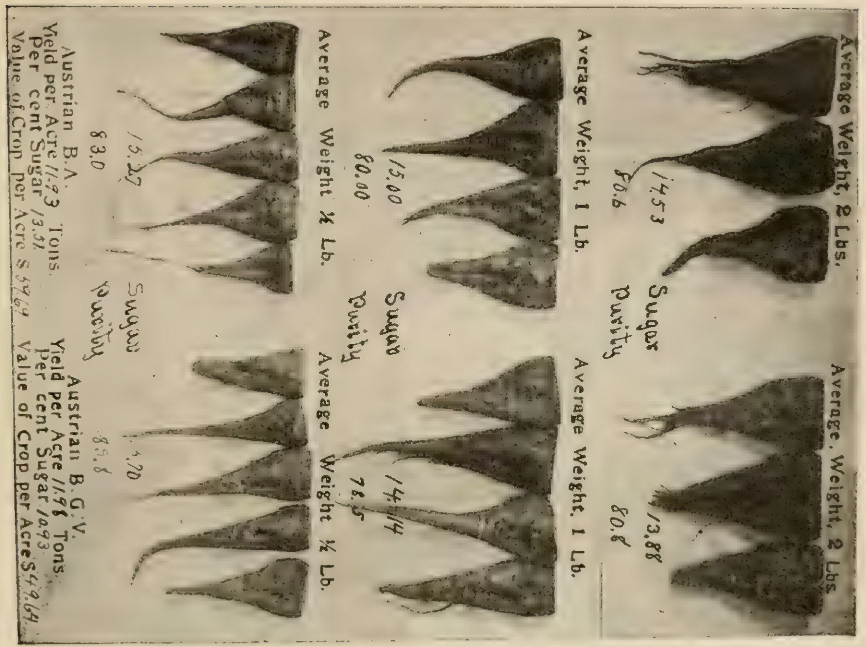
Analyses of beets of different sizes.

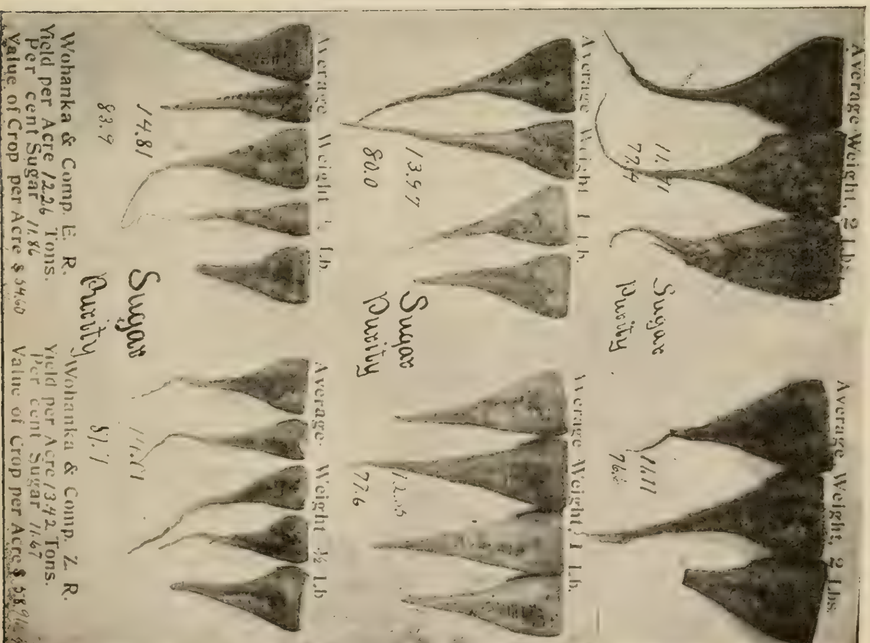
Variety.	Large, 32 ounce.		Medium, 16 ounce.		Small, 8 ounce.	
	Per cent sugar.	Purity.	Per cent sugar.	Purity.	Per cent sugar.	Purity.
No. 5,771	12.42	76.3	12.83	75.8	14.63	80.3
No. 5,772	14.19	79.6	13.49	79.9	16.10	83 6
No. 6,359	11.45	77.3	12.08	78.9	14.70	82.5
Austrian B. A.	14.53	80.56	15.80	80.0	15.27	83.0
Austrian B. G. V	13.88	80.8	14.14	78.5	15.70	83 8
Russian W. A. C	12.40	77.0	13.10	80.2	13.57	78.5
Wohanka E. R.	11.91	77.4	13.97	80.0	14.81	83.9
Wohanka Z. R.	11.11	76.6	12.35	77.6	14.01	81.7
Average	12.74	78.2	13.37	78.9	14.85	82.2

These averages somewhat contradict the conclusions of Headden in Colorado Experiment Station Bulletin No. 58 where he concludes that "Medium sized beets are apt to be better than either large or small beets, but the size is less determinative of the quality of the beets than the conditions under which they grow. Beets weighing two pounds and upwards are quite as rich as those weighing less than one pound, if they have been grown under the same conditions."


Average Weight, 2 Lbs.
Average. Weight, 2 Lbs.
12.40
Sugar
11.45
Purity
77.3
Average Weight, 1 Lb.
Average Weight, 1 Lb.
13.10
Sugar
12.08
80.2
Purity
78.9
Average Weight ½ Lb.
Average Weight ½ Lb.
13.57
Sugar
14.70
78.5
Purity
82.5
Russian W. A. C.
Yield per Acre 12.24 Tons
Per cent Sugar 11.13
Value of Crop per Acre $
6859 Meyer's Elite Kl.
Yield per Acre 12.98 Tons
Per cent Sugar 10.87
Value of Crop per Acre $


Average Weight, 2 Lbs.
Average Weight, 2 Lbs.
12.42
Sugar
14.19
76.30
Purity
79.60
Average Weight, 1 Lb.
Average Weight, 1 Lb.
Sugar
Purity
79.90
Average Weight ½ Lb.
Average Weight ½ Lb.
14.63
Sugar
16.10
80.30
Purity
83.60
5771 U.S. Dep't Agr., Hoening.
Yield per Acre 12.26 Tons
Per cent Sugar 12.65
Value of Crop per Acre $ 57.83
5772 U. S. Dep't Agr., Dippe.
Yield per Acre 11.58 Tons
Per cent Sugar 12.71
Value of Crop per Acre $ 54.85


Average Weight, 2 Lbs.
14.53
80.6
Sugar
Purity
Average Weight, 1 Lb.
15.00
80.00
Sugar
Purity
Average Weight ½ Lb.
15.27
83.0
Sugar
Purity
Austrian B. A.
Yield per Acre 11.93 Tons.
Per cent Sugar 13.51
Value of Crop per Acre $ 59.69
Average. Weight, 2 Lbs.
13.88
80.8
Average Weight, 1 Lb.
14.14
78.5
Average Weight ½ Lb.
88.8
Austrian B. G. V.
Yield per Acre 11.98 Tons.
Per cent Sugar 10.93
Value of Crop per Acre $49.64


Average Weight, 2 Lbs.
11.71
77.4
Sugar
Purity
Average Weight 1 Lb.
13.97
80.0
Sugar
Purity
Average Weight ½ Lb.
14.81
83.9
Sugar
Purity
Wohanka & Comp. E. R.
Yield per Acre 12.26 Tons.
Per cent Sugar 11.86
Value of Crop per Acre $ 54.60
Average Weight, 2 Lbs.
11.11
Average Weight, 1 Lb.
77.6
Average Weight ½ Lb.
81.1
Wohanka & Comp. Z. R.
Yield per Acre 13.42 Tons.
Per cent Sugar 11.67
Value of Crop per Acre $ 58.94

SAND LUCERNE.

J. D. TOWAR, AGRICULTURIST.

Bulletin 198—Agricultural Department.

SUMMARY.

1. Sand lucerne, *Medicago media*, is a leguminous, perennial plant, resembling alfalfa. It develops an immense root system, and is capable of producing four crops of hay annually on high, sandy soil without irrigation.

2. The best seedings are obtained by sowing alone, on well prepared ground, in early May, using about fifteen pounds of seed per acre. No crop is expected the first year, but two or three mowings with the knives set high to destroy weeds is advisable.

3. The strength and productiveness of the plant improves with age, and one good seeding ought to last many years.

4. It withstands the severe winter climate of Michigan when grown on dry sandy land. The tests on low and heavy clay lands are not yet completed.

5. To make the best quality of hay it should be cut as soon as the blossoms appear, and in curing it should be handled in the field as little and quickly as possible, to avoid loss of leaves.

6. The yield of cured hay per acre in 1901 from seeding made in 1897 was as follows:
June 18, 4.293 pounds; July 13, 4,350; August 14, 3,538; October 1, 1,688; total, 13,839. This plot of sandy soil produced in 1898 three crops of cured hay, total, 6,800 pounds. In 1899, four crops, 10,580, and in 1900, four crops, 12,310 pounds.

The land had received no fertilizer of any kind since the seed was sown.

7. The analysis of the 1901 crop shows it to contain 80.56 per cent dry matter, and digestible nutrients as follows: 11.12 per cent protein; 31.13 per cent carbohydrates, and 1.01 per cent ether extract. Or the entire crop giving per acre, 1,529 pounds of protein, 4,307 carbohydrates, and 140 pounds ether extract as digestible nutrients determined by employing the coefficient of digestibility for alfalfa. The nutritive ratio of the hay produced is 1:3.

8. The fertilizing analysis of the dry hay as determined by the average results of the four cuttings is 2.39 per cent nitrogen; .45 per cent phosphoric acid and 3.08 per cent potash, an acre producing 330 pounds of nitrogen, 62 pounds of phosphoric acid and 426 pounds of potash.

9. As green forage, hay and pasture, its close resemblance to common alfalfa argues for it all that is claimed for the latter. Attaining mature growth early in June, one can easily manage it for a continuous soiling crop throughout the growing season. As hay it is relished by all farm animals, its high protein content suggesting it as a substitute for part of the grain ration. As a pasture crop, one trial with sheep showed it capable of furnishing a liberal supply of feed throughout the season, and that the plant was able to withstand severe pasturing. Further trial is necessary to determine its true pasture value in this State.

10. Attempts to grow the seed in this State have thus far proved unsuccessful.

11. Favorable reports from experimenters have been received from 16 counties.

12. Unfavorable reports have been received from experimenters in 14 counties.

13. Owing to the high price of the seed, the time required to secure a good seeding, the increased growth and vigor of the plants that come with age and the difficulty with which a lucerne sod is plowed, it is recommended as a permanent meadow only, although numerous experiments go to show that it is a valuable fertilizing crop.

14. If grown in an orchard it robs the trees of plant food and moisture, while the trees would, in turn, take some of the fertility essential to the full development of the lucerne.

The clover family while containing numerous species of the trifolium genus which possess marked and recognized economic values, is none the less important to the farmer from the fact that it also contains the lucernes. The most familiar member of the lucerne family is the alfalfa, *Medicago Sativa, L.* This plant "has been cultivated for a forage plant for more than twenty centuries. It is a native of the valleys of the central district of western Asia, having been found in an apparently wild condition in the region to the south of the Caucasus, in several parts of Beloochistan and Afghanistan, and in Cashmere. It was introduced into Greece at the time of the Persian war, about 470 B. C. The Romans often cultivated it as forage for the horses of their armies. It was in especial favor with them as a forage crop during the first and second centuries, and its cultivation has been maintained in Italy down to the present time. From Italy it was introduced into Spain and the south of France. It was carried from Spain into Mexico at the time of the Spanish Invasion, and thence to the west coast of South America. It was brought from Chili to California in 1854, and from there it rapidly spread over the arid regions of the Pacific coast and Rocky mountains, where it is now cultivated almost to the exclusion of other forage plants.

"Lucerne was introduced into the state of New York at least as early as 1820, or more than thirty years before it was brought to California, but it has never been so extensively cultivated there as on the Pacific coast."

The above quotation from Farmers' Bulletin No. 21, U. S. Department of Agriculture, is followed a little later by the list of varieties, which includes the intermediate lucerne (*Medicago media*) and the yellow, or sand lucerne (*Medicago falcata*). Nothing further is mentioned in this bulletin relative to these latter two medicagos except that it is said that "Neither of them has much agricultural value, though the yellow lucerne is sometimes recommended for planting on very light and sandy calcareous soils."

It is quite probable that, at the time the bulletin referred to was written, very little work had been done in this country with the Medicago media, which came to the Michigan Exepriment Station under the name of sand lucerne. Under date of March 13, 1901, Mr. C. C. Maas, for the Wernich Seed Company, Milwaukee, Wis., writes us the following relative to the "sand lucerne":

"We procure the seed in Europe from a reliable and old-established seed house. Botanically it is known as Medicago-falcata-sativa or Medicago media. Dr. Edwin Birnbaum, director of the Agricultural College at Liegnitz, Germany, in his book on 'Meadows, Pastures and Fodder Plants' describes it as a bastard, cultivated in many localities in Europe as a clover for sandy soils. Will do well on any other soil. In growth it is about half way between Lucerne and Swedish alfalfa (Medicago falcata). Its peculiarity is that it will vary sometimes in the bloom, the flower sometimes being yellow, green, blue, violet and their various shades. Its growth the first year is very tardy. Once started it will yield three or more crops a year. It is very slow in starting in the spring, but, seeding on the contrary should be very early, so that seed gets benefit of plenty of moisture. In extreme cases of drouth-suffering localities it should be sown with grain, but the latter is not to be left to ripen or it will smother the small plant.

"Its feeding qualities are not as good as that of the ordinary lucerne, but it has the advantage over the latter that it does not bloat cattle as easily. It also stands pasturage better than lucerne. * * * We have so far heard of no failure in crop, no matter where sown, whereas it is a common occurrence in northern climes for lucerne to fail."

DESCRIPTION AND HABITS OF GROWTH.

In appearance and behavior the difference befween the sand lucerne and alfalfa is so very slight that only an expert botanist could note the botanical characteristics which distinguish each, and a most careful observer could discern wherein one differs from the other. Below is a brief comparison of the two plants, as noted by Professor C. F. Wheeler, botanist of the Experiment Station.

THE BOTANICAL HISTORY OF SAND LUCERNE.

(Medicago media, Pers.)

*"There has been a difference of opinion, among European botanists, in regard to the relationship of sand lucerne to other lucernes or alfalfas, viz.: *Medicago sativa,* ordinary alfalfa, and yellow lucerne, *Medicago falcata.* Alefeld and other botanists unite common alfalfa, sand lucerne, and yellow lucerne into a single species. Some botanists look upon alfalfa and yellow lucerne as distinct species and consider sand lucerne as a hybrid between them. Others regard them as distinct species. The three forms differ so widely in agricultural value and other characters that they cannot be treated together."

The ordinary characters between alfalfa and sand lucerne are easily recognizable when the two are grown side by side.

The stiff habit of alfalfa differs from the more spreading habit of sand lucerne. The flowers of the former are bluish to violet-purple, while those of the latter range from bluish and purple to lemon yellow, with many intermediate shades. The pods of alfalfa are coiled in about two turns, while those of sand lucerne are in three-fourths of one coil. The seeds of the sand lucerne are lighter than those of the alfalfa. Five hundred seeds of sand lucerne weigh from 0.8 to 0.9 grams, while the same number of seeds of common alfalfa weigh from 1.0 to 1.037 grams.

Owing to the extremely close resemblance of the sand lucerne to our common alfalfa, not only in its manner of growth and botanical characters, but in its chemical and physical characteristics, the author has employed a few references to results from the culture and feeding of alfalfa in discussing the sand lucerne, fully realizing that the further study of these two closely related plants may reveal many differences not yet known.

As a honey crop alfalfa is regarded as particularly valuable. Hunter, in Contrib. Ent. Lab. Univ. Kansas, 1899, No. 65, gives testimony as to the excellence of the quality of honey obtained from alfalfa, and in return for the honey, records an experiment where the honey bees increased the seed crop by 66⅔ per cent over fields not visited by the bees. To grow it, however, as a honey crop would be practical only where the crop is to be used later for seed, for in the growing of lucerne hay, the crop is harvested before the blossoms are out sufficient for the bees to secure nectar.

Like the alfalfa the sand lucerne is a deep-rooted perennial plant, sending its tap roots to distances of twelve, fifteen, or even more, feet into the ground, with numerous large branching roots which seem to increase and multiply as the plant grows older. In the fall of 1899 some two-year-old plants were traced in light sandy soil to the depth of seven and one-half feet, where the tap root was one-eighth of an inch in diameter. Like the alfalfa, it prefers the loose sandy sub-soil and seems to thrive best where the water is a considerable distance from the surface. It has the special advantage over alfalfa of being able to withstand the severe winters of Michigan climate, while the alfalfa is very easily killed out. It is said of the alfalfa, too, that it is liable to be crowded out by June grass, sorrel and other weeds. So far no difficulty of this nature has been noticed with the sand lucerne seedings. It is quite probable that instead of the weeds running out the alfalfa, the alfalfa has been killed during the severe winter and the weeds have simply taken its place. It makes a somewhat slow growth, similar to the red clover, during the first season, and is not to be depended upon for a crop until the second year. Some plants from seed sown at the Experiment Station farm at Chatham, Alger county, Upper Peninsula, on June 6, 1901, produced plants with tap roots over eighteen inches long, and the stems thirty-six inches above the ground when they were harvested on August 31 of the same year. On the Experiment Station farm at the College the growth for a similar period was twenty-three inches of stalk, the roots were not measured.

In the successful growing of the lucernes, aside from furnishing the necessary mineral elements to the soil, the plants must have access to a liberal supply of water, but in order to insure the thorough establishment of the root system in a deep volume of soil, it is especially important that the water table be not nearer than one or two feet from the surface.* Buffum found that the water used in one season by the alfalfa crop would cover the ground to the depth of 2.22 feet. To secure this abundant supply it is evident that the plants must get their water from the deep sub-soil. For in this locality we never have that amount of rainfall during the growing season. Between the first week in April and October 1 we had in 1899, 11.25 inches; in 1900, 16.68, and in 1901, 17.23 inches. Their enormous root system, however, is capable of pumping up the necessary supply, provided the plants are grown in soil where there is some encouragement for the roots to go down deeply. The failures to grow the common alfalfa in Michigan, as before recorded, are due largely to the winter killing of the plants. From the experience, however, of numerous experiments, it is learned that winter killing is due largely to surface water which freezes about the crowns of the roots, thereby destroying them. The lucerne cannot live on soils where the water stands on the surface during the freezing weather.

---

* The Best Forage Plants, Stebler and Schroeter, p. 147.

THE SOIL AND SEEDING.

The early introduction of alfalfa into Michigan was attended with considerable misfortune. It came originally as a clover with the instruction that if treated the same as red clover it would prove a valuable substitute, giving three or four crops annually, of a superior quality of hay. Under these instructions alfalfa seed was sown on a large number of Michigan wheat fields in the same manner that clover seed was usually sown in the spring. The result was almost complete failure of the alfalfa crop, and wherever it did grow and a few plants appeared the following year for harvest, they were cut and cured in the same manner, and at the same time, as red clover. The result was a perfectly valueless harvest, so far as the alfalfa was concerned. Were such methods employed for growing the sand lucerne a similar result would be the outcome.

The soil for which sand lucerne is best adapted is one with a subsoil which will permit and encourage the roots to grow and develop at considerable depth. The lucernes grow especially well in sandy soils and show their superiority in those light soils where other crops generally suffer and die from drouth. Being a leguminous plant, the lucerne takes in atmospheric nitrogen through the clustered tubercles which develop on its roots near the surface of the ground. It therefore follows that a soil deficient in nitrogen provided it contains enough moisture and fertility to give the plants a good start will probably exhibit the good qualities of the lucerne to best advantage. Mr. C. R. Ferguson of Almont, Michigan, grew over a ton of dry hay to the acre the first year on deep muck, and found a large number of plants alive on the plot the next spring.

The ground should be carefully prepared early in the spring, by thorough, deep plowing followed by the roller, unless the ground is a clay loam or clay, and this succeeded by the harrow sufficiently to prepare a good seed bed for wheat or corn. The seed should then be sown early enough in the spring, say about May 1 to 15, to give it the benefit of spring moisture.

Seedings made at the Michigan Experiment Station early in the season, that is before June 1, have always been successful. A June 12 seeding gave about three quarters of a crop, while a July 12th seeding was a complete failure.

QUANTITY OF SEED AND METHOD OF SEEDING.

The quantity of seed to sow per acre will vary with conditions. The seed being small, just a little larger than the common red clover seed, growth at first will naturally be slow. In all probability the weeds will come on during the summer, and unless kept back by frequent clippings with the scythe or mowing machine will crowd out the young lucerne plants, and destroy the prospects of a crop. This period is the most important one in the life of the plant, and when one considers that a single seeding is destined to last, if well established, for twenty years or more, he can well afford to give it good care and the best possible chance. Seedings of fifteen pounds per acre have given good results, and unless by careful test of the seed its germination is found to be low, and the soil on which it is to be sown is particularly poor it will probably be safe to use that amount. A greater amount than this would probably be preferable if the soil was in any way reduced in fertility. With seed so fine and where the quantity sown is so small, sowing broadcast by hand tools, or with the wheelbarrow seeder is preferable. One passing with a light harrow is sufficient to cover the seed.

---

* Wyoming Experiment Station Bulletin 43.

The sowing of clover or lucerne as a crop by itself is a practice not much in vogue as yet in this State. We have at the Michigan Experiment Station succeeded in getting a successful catch in sowing with other crops, but the practice is usually attended with a decreased yield and sometimes almost complete destruction of the lucerne. Several experimenters who have tried the sand lucerne in a small way in Michigan have sown it with oats and other spring crops, and found upon harvesting the nurse crop that the sudden exposure to the sun and the rapid drying of the soil which followed, has resulted in complete loss of the lucerne. In Buffum's experiments, Bulletin 43, Wyoming Experiment Station, he finds that the first year after sowing he obtained 2,414 more pounds of hay without the oats as a nurse crop than where the oats were used. The difference the next year was only 360 pounds in favor of no nurse crop.

HARVESTING THE CROP.

There is danger of allowing the crop to get too ripe before it is harvested. This is a matter of great importance. The crop should be cut as soon as the first blossoms appear. A few days, even two or three, of delay in this work will allow the plants to get too mature, the stems become so woody as to be perfectly valueless, while in the process of curing, the leaves will entirely fall off, leaving as the harvested crop nothing but the hard, woody, indigestible stems, which possess but little or no feeding value. In curing the crop, care should be taken to avoid much handling in the drying sun. It is better to rake the crop into windrows and then bunch and allow to cure in this manner slowly, than to let it lie in the swath and give it the frequent stirrings with the hay tedder that are sometimes practiced in making clover hay. With good haying weather there is little difficulty in curing it the day after it is mown while not infrequently it has been cut and hauled the same day.

USES.

In the problem of supplying balanced rations for farm animals, it is usually found that the roughage and even the grain produced on the farm failed to supply the requisite amount of protein or nitrogenous material. The alfalfa and sand lucerne hay furnish a proportion of this protein so high that it can fed with a feed quite deficient in that material and yet the mixture will result in a balanced feed. For example, the average ration required by farm animals is about one part of protein to six parts of carbohydrates and fat. The sand lucerne, with the ratio of one to three, which is termed a narrow ration, may be fed with corn, corn fodder, corn stover, timothy and mixed hay or straw, which have wide ratios—that is, they are low in potein—so that the combination will give the desired ratio of one to six. The experiments recorded below go to substantiate this statement.

The sand lucerne hay has an agreeable aroma, and in feeding it we find all farm animals devouring it with a relish equal to that for the best clover hay. In the western ranches where alfalfa hay constitutes so much of the feed supply, it is the sole feed of many of the farm horses doing the ordinary farm work, and with a little corn or barley it supplies a good working feed.

Mills, in Bulletin 44, Utah Experiment Station, found that mixing straw in the feed with alfalfa, thereby widening the ration, he got better results in feeding steers than from feeding exclusively on alfalfa as roughage.

The first crop of sand lucerne is ready to cut from the first to the fifteenth of June. Like alfalfa, it is quite possible to use it at this time as a soiling crop. And when dairymen are depending on some early crop to cut and feed to their cows, the sand lucerne comes in at a very opportune time, preceding, at it does, nearly all of the common forage plants of this latitude. As a hay crop, the analysis given later will indicate clearly its great value.

As a pasture, it comes on early in the spring, grows promptly and rapidly after once being cut or eaten off, and gives a continual supply of green forage throughout the season. Unless cropped off too closely it withstands perfectly the effects of pasturage, as will be shown in an experiment recorded later.

ALFALFA FOR MILCH COWS.

*In 1899, Cottrell made inquiries throughout the state of Kansas to learn in what localities the cows were giving the best returns. The result of this inquiry revealed the fact that the best results from feeding dairy cows were received in those parts of the state where alfalfa hay was a prominent feed.

GREEN RYE AND ALFALFA AS SOILING CROPS.

In the Experiment Station Report, volume 10, p. 295, the following quotation from an experiment at the Ontario Agricultural College where rye and alfalfa were compared as soiling crops is given: "The rye, which was a medium crop, yielded at the rate of 12,375 pounds of green fodder per acre and the alfalfa yielded a first cutting at the rate of 15,300 pounds of green fodder per acre. The alfalfa was eaten rather more readily by the cows than the rye. The milk yield was slightly in favor of the alfalfa. When scored by an expert the rye butter scored 35 points for flavor and the alfalfa butter 40 points for flavor, out of a possible score of 45 points. The plat of alfalfa furnished two subsequent crops, which made the total yield from the alfalfa plat more than double that stated above, whereas the rye made but an indifferent second growth."

Voorheis and Lane in New Jersey Experiment Station Bulletin 148, conclude that "The crop is well adapted for soiling and for hay. The average yield of green forage per acre for three years (including the first year) was 18.27 tons, equivalent to 4.57 tons of hay. The yield the third year from five cuttings was 26.6 tons of green forage, equivalent to 6.65 tons of hay, costing $3.69 per ton."

"A feeding experiment showed that the protein in alfalfa hay could be successfully and profitably substituted in a ration for dairy cows for that contained in wheat bran and dried brewers' grains, and for this purpose is worth $11.16 per ton, when compared with the wheat bran and dried brewers' grain at $17 per ton."

"The use of alfalfa hay reduces the necessity for the purchase of protein feeds."

New York State Bulletin No. 80 records in full a series of experiments with *Alfalfa Forage for Milch Cows* which result generally favorable to the feeding value of alfalfa, and particularly to its palatability.

ALFALFA FOR HORSES.

Muntz and Girard made an extensive study of the composition of alfalfa in experiments with horses, to determine the digestibility both as green forage and cured hay. The alfalfa was fed alone and mixed with meadow hay. The experiments were continued usually for a period of twenty-one days. The conclusions are that as regards nitrogenous material alfalfa is superior to meadow hay, but as regards carbohydrates the hay is superior.†

As a pasture for sheep, the following experiment was tried on a one-tenth acre plot during the season of 1900:

A movable pen 16 feet long and 8 feet wide was, on May 1, started at one end of the plot, which was one rod by 16, and moved each day at a rate sufficient to pass over the entire area four times in five months. Until July 1 a Dorset ewe and two lambs were kept in the pen, then the ewe was removed and the lambs left there alone. Up to August 15 the lambs gained constantly and had increased 82 pounds in weight. They received, in addition to the lucerne pasture one pint of oats daily. After August 15 the lambs continued to fall off in condition and weight. Had the experiment been a feeding experiment only it would have been policy to remove the lambs at this time, and give them a change of feed, but in order to further test the vigor of the lucerne, under continued pasturage and learn if possible its injurious effects upon the lambs, they were continued in the experiment until October 1, when one of them died, followed a few days later by the other.

Conclusions are that the crop will furnish abundant pasture, and that pasturage by sheep is not injurious to the crop as evidenced by the complete growth which appeared again this year. Perhaps it will be necessary to avoid making of it an entire ration for animals during the fall, when the natural food is of a less succulent nature. Post mortem examination of the lambs revealed no symptoms of poison from the effect of the lucerne feed.

---

* Kansas Experiment Station Bulletin 85.
† Annals Agron., 24 (1898), No. 1.

Burnett, in Nebraska Experiment Station No. 71, notes the death of nine lambs out of a flock of 129 from alfalfa pasture between October 18 and November 1. There were, however, no cases of bloat and the post mortem examination revealed no symptoms that would explain the cause of death.

The pasturing of sheep on alfalfa seems to be attended with some dangers, and must be done with more or less precaution.

SHEEP FEEDING.

Burnett, in Nebraska Experiment Station Bulletin 66, records an experiment comparing alfalfa with native hay in connection with grains for fattening lambs, and in Bulletin 71 comparing in a similar way alfalfa and sorghum hay. A notable feature of both experiments was the fact that much more feed, both hay and grain, was consumed by the alfalfa fed lambs than by those fed on the other hays, but in every case the extra feed was more than returned in the increased growth.

The following conclusions from the first experiment so far as alfalfa is concerned are significant: "The alfalfa fed lambs consumed 1.34 pounds of alfalfa and one pound of grain per day, as against .88 pounds of prairie hay and .89 pounds of grain consumed by the prairie hay fed lambs."

"The alfalfa fed lambs made 52 per cent greater gains than the lambs fed prairie hay and the same grain ration."

From the second experiment the following testified to the superiority of alfalfa over sorghum hay:

1. Six lots on alfalfa and different grain rations made an average gain of 33.7 pounds per head in 98 days.
2. Three lots on sorghum and different grain rations without linseed meal made an average gain of 20.7 pounds per head in 98 days.
3. Six lots on alfalfa made an average profit of 72 cents per head on food consumed.
4. Four lots on sorghum made an average profit of 32.8 cents per head.

Day in Ontario Agricultural College and Experiment Farm Report, 1898, records an experiment comparing clover hay and alfalfa hay as a feed for fattening sheep, wherein there is a slight advantage in favor of the alfalfa hay.

Foster, in Bulletin 47, Wyoming Experiment Station, gives results of lamb feeding experiment to compare feeding values of alfalfa with that of native hay in connection with corn for finishing lambs for market. Two pens of lambs, 50 each, were fed for 95 days. The lambs were of mixed Rambouillet, Lincoln, Shropshire and native. The account of the experiment closes with the following facts and conclusions:

Foods, gains and values.	Native hay.	Alfalfa.
	Pounds.	*Pounds.*
Hay eaten per head daily	1.07	1.47
Corn and oil cake eaten per head daily	.82	.82
Hay consumed for 100 pounds gain	420	456
Grain consumed for 100 pounds gain	317	248
Average gain per head in 95 days	24.1	30.8
Average daily gain per head	.253	.324
Gain per ton of hay	476	439
Gain per acre of hay	476	1,756
Cost of food per head for 95 days	$1 08	$1 20
Value of food eaten per 100 pounds gain	4 48	3 89

Among the conclusions arrived at, the following bear directly on the comparison of the two kinds of hay: "The alfalfa hay surpassed the native in the following points: 1. It produced 27.8 per cent larger gains. 2. It gave 1½ per cent more of dressed carcass. 3. It produced 1,280 pounds more mutton per acre. 4. Its gains were made at 15 per cent less cost for food per hundred.

"The native hay excelled the alfalfa in the number of pounds of hay eaten for 100 pounds gain, requiring 26 pounds less, though the total amount of food required was 43 pounds more. This set also ate 219 less food and cost 12 cents per head less for the food eaten during the experiment.

* Beach, in bulletin on Montana Swine Feeding, concludes: "Alfalfa, or clover pasture, with a little grain in the summer affords conditions for cheapest growth and greatest profit.

Kansas Press Bulletin No. 25 gives results where alfalfa was fed to hogs in connection with grain proving that alfalfa hay also gave a variety to the hay, making it more appetizing and inducing the hogs to eat more grain. The hay fed hogs ate more grain and gained more for each bushel eaten. In a pasturing experiment where some corn was fed with the alfalfa pasture, it was concluded that after deducting the probable gain from the corn, the gain per acre from the pasture was 776 pounds of pork. "These facts indicate that to produce pork most cheaply the Kansas farmer must have alfalfa pasture in summer and alfalfa hay in winter."

Morrow and Bone, in Oklahoma Experiment Station Report, 1900, conclude: "Alfalfa is excellent pasture for hogs. Pigs will make some gains with no other feed. Excellent gains when fed grain while on alfalfa. Continuous pasturing will injure and may kill alfalfa. With rare exceptions, alfalfa should not be pastured the year it is sown.

Bulletin 104, Kansas Experiment Station, Cottrell concludes as follows: "Alfalfa hay is one of the best feeds for sheep that is grown and both green and dry alfalfa are valuable feeds for poultry. On account of its effect on their skin and hair, alfalfa is one of the best feeds for cattle being fitted for the show ring. Alfalfa makes good pasturage for horses. Horsemen report a gain of six pounds per day per head pastured on alfalfa and given a light ration of corn or kafir corn."

EXPERIMENTS IN GROWING.

In the spring of 1897, on May 15, three plots of sand lucerne were sown on the Experiment Station grounds; one, an area of one and one-fourth acres, on a rolling, sandy field with gravelly subsoil, where 25 pounds of seed were used. This plot was sown adjacent to one on which the common alfalfa was sown at the same time. The yields from this plot have never been carefully recorded, although the sand lucerne is still growing on the plot, and has annually produced one crop of good hay. The remaining growth either being pastured or left to mulch the ground. The alfalfa grown adjacent to this was so badly winter killed that it has been plowed up and the ground used for other purposes. There are a few small areas in the sand lucerne plot which have suffered from winter killing.

The two other plots sown to sand lucerne were on some of the lightest sandy soil to be found on the College grounds. These plots have been carefully watched and every pound of the crop has been carefully weighed and recorded. The larger of the plots, containing one-sixth of an acre, has been used exclusively for harvests of cured hay. The other was harvested as hay in 1898 and 1899, used for pasturage experiment in 1900, and tried for growing seed in 1901. The yield per acre from three crops on this plot in 1898 was 5,917 pounds, and in 1899, from four crops, 8,480 pounds to the acre. The plot from which cured hay has been harvested each year has given the following results:

Harvest of 1898, three crops, 6,800 pounds per acre.
Harvest of 1899, four crops, 10,580 pounds per acre.
Harvest of 1900, four crops, 12,310 pounds per acre.
Harvest of 1901, four crops, 13,839 pounds per acre.

The dates of cutting the above have averaged about June 10, July 12, August 15, and October 1.

The crop of 1901 furnishes the following table. Immediately after each harvest samples of the cured hay were taken and carried to the chemical laboratory, where, under the direction of Dr. R. C. Kedzie, the analyses for feeding values and fertilizing elements were carefully made.

---

* Montana Experiment Station Bulletin 14.

Results of yields and analyses of sand lucerne hay grown at the Michigan Experiment Station.

Dates of harvest.	1901.				
	June 18.	July 13.	Aug. 14.	Oct. 1.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Yields per acre	4,263	4,350	3,538	1,688	13,839
Total moisture	9.56	23.79	26.72	17.95	19.44
Crude protein	16.63	15.29	13.35	12.92	14.92
Ash	7.35	8.62	7.14	7.31	7.69
Ether extract	3.26	3.24	1.61	21.16	2.57
Crude fibre	29.04	23.20	22.65	25.44	25.13
Carbo-hydrates	34.16	27.60	28.53	35.22	30.78

The following table gives the dry matter, the digestible nutrients according to the coefficients of digestibility of alfalfa, as given in Henry's book on "Feeds and Feeding," together with the fertilizer analyses of the several crops:

Date of harvest.	Yield per acre, pounds.	Analysis—pounds in 100.						
		Dry matter.	Digestible nutrients.			Fertilizing elements.		
			Protein.	Carbo-hydrate.	Ether extract.	Nitrogen.	Phos. acid.	Potash.
June 18	4,263	90.44	12.31	35.03	1.27	2.66	.47	2.98
July 13	4,350	76.21	11.31	28.19	1.26	2.45	.47	2.89
August 14	3,538	73.28	9.88	28.56	.63	2.14	.42	3.18
October 1	1,688	82.05	9.56	34.18	.45	2.07	.42	3.02
Total	13,839	80.56	11.12	31.13	1.01	2.39	.45	3.08
Total pounds per acre	....	11,146	1,529	4,307	140	331	62	426
Louisiana analyses	....	88.76	12.58	36.15	.91	2.71	.67	2.85

The above Louisiana experiments were reported by Stubbs in a Louisiana Station Bulletin 55. The cuttings were made May 9, June 8, July 1, and August 1.

The nutritive ratio of the average of the Michigan Experiment Station results is 1:3.

According to the Kansas Experiment Station Press Bulletin 41, 100 pounds of alfalfa hay contains 11.3 pounds more digestible matter than red clover, and 1½ times as much protein. It contains five times as much digestible protein as corn fodder, almost as much as wheat bran, and more than wheat, corn, oats, rye, barley, kafir corn and sorghum seed.

According to Zuentz, Hagemann and others, the true nutritive value of alfalfa in terms of energy are 928 Calories as compared with medium hay with 721 Calories, and red clover with 667 Calories.

It will be seen by the above that the annual yield gradually increased to the fourth year, when the crop of cured hay was nearly seven tons per acre. Another plot, seeded in 1900, gave the next year three crops, amounting to 6,580 pounds of dry hay per acre. A fourth crop was ready to cut on October 1, but was left as a mulch protection during the winter.

The feeding analysis, as compared with the Louisiana results, would be more closely parallel were they figured from a water free basis. Taking the June 18th cutting, which was more thoroughly dried than any of the rest, we find them to differ but slightly. The quantity of nitrogen and potash removed by this crop is simply enormous, and the source of the former can be accounted for only through the assimilation of atmospheric nitrogen by the tubercles on the roots. That the lucerne is capable of growing successfully for a time without the addition of fertilizers is proven by the experiments of Voelcker[*] who took a piece of "clover sick" land in the Stackyard field at Woburn in 1889, sowed it carefully to lucerne and applied several forms of fertilizers. To the first was given superphosphate and bone dust; to the second, sulphate of potash; to the third, sulphate of ammonia; to the fourth, nitrate of soda; to the fifth, superphosphate, bone dust, sulphate of potash and sulphate of ammonia; and to the sixth, the same as to the fifth except that nitrate of soda was substituted for the sulphate of ammonia. A seventh plot was left unmanured. The amount applied was four hundredweight of each material, whether alone or in combination, with the exceptions of the nitrate of soda and sulphate of ammonia, of which two hundredweight were applied. Three, and sometimes four, cuttings were obtained each year, and the product weighed green. "For the first seven years (1889-95) the manures showed no benefit, while the sulphate of ammonia distinctly reduced the product. From 1896 onward there has, however, been a distinct change in the application of sulphate of potash or of manures containing it, having shown a marked increase.

An examination of the yields from the unmanured plot, showed that for seven years it held its own with the manured plots, when, evidently, the available potash, owing to the enormous annual draft upon its supply, began to be exhausted. The fact that annual applications of nitrogen during the seven years showed no benefit, gives further evidence of the ability of the legumes to assimilate from the soil atmosphere sufficient nitrogen for their profitable growth.

FERTILIZING VALUE.

A plant whose roots penetrate so deeply into the subsoil and which converts so much atmospheric nitrogen into organic nitrogen can but add a material supply of fertilizing elements to the farm. According to Headden, who noticed that the roots penetrated to twelve and twenty-five hundredths feet in a homogenious clay, the roots within reach of the plow added to the stubble left by the first mowing is equal to two-thirds of the green lucerne removed. This material, together with the fertilizing value of the feed removed, which if consumed on the farm will be largely returned to the land in the form of stable manure, is, certainly an important factor in maintaining the fertility of the land.

There are numerous experiments on record where the beneficial effects of lucernes have been very large, not only in improving the mechanical condition of the soil but in actually adding to its fertility.

In a series of experiments performed at the Wyoming Experiment Station recorded in Bulletin 44, the following results are summarized: "When alfalfa land was plowed and planted to wheat it produced $8 to $12 more value in wheat per acre than the land which had grown potatoes and grain before." "When alfalfa land was plowed and planted to oats it produced $16 worth of grain more than land which had grown potatoes and grain before." "When alfalfa land was plowed and planted to potatoes it gave $16 worth more of potatoes per acre than was obtained from land which had grown potatoes and grain before." "By growing alfalfa the above increase of yields and values were produced with absolutely no cost for fertilizing the land."

In Bulletin 57, Colorado Experiment Station, Cooke compares alfalfa sod with old land for growing potatoes. The average from a large number of plots gave 3,610 pounds of merchantable potatoes, compared with 1,277 pounds grown on equal area of old ground.

Numerous inquiries are made relative to sowing lucerne as a permanent orchard crop. It is evident from the extensive root system developed by this plant that it would probably rob from the trees some of the moisture and nourishment necessary for their complete development. While no experiment has been tried at the College to determine this, the following conclusion found in Experiment Station Report, volume 12, p. 1048, gives conclusions from Hessische Landw. Ztschr. stating that "Alfalfa seriously retarded the growth of young apple trees as compared with trees grown on land in cultivated crops and wheat."

---

[*] Journal of the Royal Agricultural Society, 1900, pp. 603, 604.

REPORTS FROM FARMERS WHO HAVE TRIED THE SAND LUCERNE.

In the spring of 1900 samples of six ounces each of sand lucerne were mailed to 135 farmers in the State who had expressed a willingness to try it. In June, 1901, reply postal blanks were sent out for reports of the first cutting. Of the 41 replies received, two did not get the seed, nine did not sow it, fourteen report total or partial failure, though nearly all wished to try it again, and sixteen report favorably. Some of the reports are given below.

EDWARD E. EVANS, WEST BRANCH, MICHIGAN, JUNE 10, 1901.

The quantity of seed received was small, and was sown too thinly to enable me to tell with any degree of accuracy what the yield would be. Considering the soil (sand) the growth last season was very good, and it did not winter-kill at all. Our spring has been very cold and backward, but without frosts. The growth has been comparatively slow, and I think it will be ten days before clover can be cut. It stands 18 to 20 inches in height. I was so well satisfied with last season's growth that I sowed 25 pounds this spring, and shall sow a couple of bushels next year.

JUNE 30, 1901.

Replying to your favor of the 13th inst. and in addition to my former report, will say that sand lucerne has made a growth of five to seven inches since cutting. The new seeding now stands eight to twelve inches in height. Shall cut it the coming week on account of weeds.

DECEMBER 31, 1901.

I can say definitely and positively that each of the three cuttings this year on the piece sown May 5, 1900, was heavier than I ever saw grown on such light soil, no matter what other variety was sown. Of the larger piece sown last spring, I can only say that the outlook is fully as promising. It was cut once to kill weeds, and when the ground froze, it was a solid mass of green, many single plants were so large and firmly rooted that a man could not pull up the plant. I shall sow more of it this coming spring, and will distribute seed to sandy land farmers here for trial.

CAPTAIN H. P. DANFORTH, ANN ARBOR, MICHIGAN, OCTOBER 16, 1901.

The ground sowed is about one square rod. It is on a corner of a lot in town, and the ground used had been graded and twelve or sixteen inches of the top soil scraped off, leaving a bed of sand and gravel on which the seed was sown May 10, 1900. The seed germinated in less than a week and furnished three good crops, with a fourth as good as the three that were cut, which I let remain on the ground for winter protection. I could not discover that one single root was injured by hard freezing. It started early last spring, and has furnished four cuttings, the last cut about the 28th of September, and the patch now shows green and is about four inches high. I am so situated that it is not practical for me either to weigh it green or after it is cured. I have let different ones cut it for feed for horse and cow, and all report to me that it was eaten with relish.

JOHN F. MILLER, TRAVERSE CITY, MICHIGAN, JUNE 30, 1901.

The sand lucerne was sown under rather unfavorable circumstances, and I did not get a good stand, and plowed up half of it this spring, leaving a strip next to the fence of the pasture about seven feet wide. I was away from home when it began to blossom, but it is about half out now, and I will cut it and throw it over the fence to cattle. They eat it readily. I have no means of weighing it, but it is two feet high and will probably weigh 150 or 200 pounds, while the common red clover sown near by, with a better chance, will not pay for cutting. I wish my entire farm was seeded with it. It is hard to tell it from alfalfa. I don't think that good soil would hurt it, but it will live where other clover will not.

FRANK D. WELLS, ROCHESTER, MICHIGAN, JUNE 7, 1901.

The sand lucerne was in a place which we found desirable to plow this spring. The little that remains is excellent. Think I shall try it on a larger scale.

BENJ. F. BATCHELER, HOWELL, MICHIGAN, JUNE 22, 1901.

Mr. Batcheler has a plot of sand lucerne sown in the spring of 1900, which is six rods long, and three rods wide. He harvested from it, from a June 12th cutting, 640 pounds of cured hay. He writes as follows:

"I did not get all the growth, as I cut it with a machine and it was quite badly down. Think there would have been 700 pounds had I got the whole. The hay is sufficiently cured to keep, but heavier than it will weigh out after drying in the barn. Have not tested its feeding quality yet. If it proves good forage and stands the winter, I think it will be a good thing. It took much time to cure the hay. Had hardly commenced to blossom."

WM. F. BARR, SHERWELL, MICHIGAN, JUNE 15, 1901.

Mr. Barr cut and harvested 100 pounds of hay from a plot covering 1,000 square feet. This would give him 4,356 pounds of cured hay from the first cutting. He writes as follows:

"Ground light sand, some seed seems to be just coming that dropped last fall, as I did not cut the last crop. Got about one-third of a stand last spring. Pulled a stalk with tap root two feet long. Believe I would like it if I could get a good stand."

F. O. WITHERBEE, SHELBY, MICHIGAN, JULY 24, 1901.

Cut 130 ponds of hay from 1,400 square feet. This would give about two tons of cured hay to the acre. "Stand rather irregular from sowing broadcast on small plot with small amount of seed. Stood winter well. Very dry since cutting, making fair growth. About ready to cut again."

JOHN MAXWELL, MT. PLEASANT, MICHIGAN, JUNE 25, 1901.

The sand lucerne seed you sent me last year came up good, and made a good growth the first year, and looked well this spring, but now is turning yellow and dying.

Mr. Maxwell did not cut the lucerne in time, and, naturally, it instead of dying was simply beginning to ripen. It should have been cut probably about June 1.

PHILLIP BARTON, LAPEER CITY, MICHIGAN, JULY 8, 1901.

We sowed the sand lucerne last spring, a year ago, with rye. It grew well until the rye was cut, then the hot sun seemed to burn it, so that it all died.

COW PEAS, SOY BEANS AND WINTER VETCH.

BY J. D. TOWAR.

Bulletin 199—Agricultural Department.

SUMMARY.

1. Cow peas, soy beans and winter vetch are successful new legumes for Michigan and give promise of valuable usefulness as feeds and green manure.

2. Cow peas are tender, succulent, vinelike plants and must be grown between the periods of frosts.

3. In general, cow peas will grow best when sown in rows, using one-half bushel to three pecks of seed per acre.

4. Soy beans are a little more hardy than cow peas, growing with stiff, erect stalks, but treated like cow peas.

5. Winter vetch may be sown either in the spring or fall. Its behavior is much like field peas.

6. Cow peas may be used for fall pasture for hogs and other stock.

7. Soy beans ripen their seed and shed their leaves as soon as frosts come. The seeds, being very rich in protein and fat, give promise of becoming a substitute for linseed and cotton-seed-meal.

8. Winter vetch, seeded in the spring, makes excellent fall pasture, which remains green through the winter.

9. Winter vetch as a substitute for clover has been grown best by seeding in the fall, using a half bushel of wheat and half bushel of vetch, cutting the whole in the middle of June for hay.

10. Cow peas and winter vetch make excellent green manure, and as such give best returns if plowed under when near the mature state. Either, sown in the summer in the orchard, will make a good cover crop for winter.

COW PEAS, SOY BEANS AND WINTER VETCH.

With Hellriegel's discovery in 1888 that the leguminous plants through microorganisms on their roots were capable of assimilating nitrogen from the soil atmosphere, came at once great prominence to crops of this family as soil improvers and stock feeds. By assimilating nitrogen from this source these plants furnish ammonia for fertilizer and albuminoids or protein as feed for our animals without depleting the fertility of the soil. It is, therefore, highly important that members of the leguminous family be given a prominent place in the list of crops grown on the farm, be the purpose for which they are grown whatever it may. A complete list of the leguminous plants contains all of the clovers, luzernes, peas, beans, vetches, lupins, serradella, peanuts and a large number of other plants, including many trees and shrubs. The cow peas, soy beans and winter vetch come within this family, and have so many prominent characteristics as soil renovators and stock feeds that they promise to be generally adopted as economical forage and green manuring crops for the State of Michigan. A glance at the analyses of these legumes and a number of other of our common crops grown for similar purposes, in the table below, will at once give the reader an idea of their economic importance.

In considering these feeding values, we look first to the digestible protein, then the digestible carbohydrates, and ether extract. The protein is determined by multiplying the percentage of nitrogen by 6¼. The digestible protein and carbohydrates are ascertained by using a factor of digestibility determined by experiments performed either by the chemist or by actual experiments with domestic animals. The ether extract or fat is converted to the basis of carbohydrates by multiplying by a factor ranging from 2¼ to 2½, and then added to the digestible carbohydrates. Then the ratio between the digestible protein and digestible carbohydrates and fat is known as the nutritive ratio. Thus it will be seen that materials rich in nitrogen will show in the ratio a smaller number as a second term, while those very rich in carbohydrates and fat and low in nitrogen will show a very large figure as the second term of the ratio. Where the ratio is 1 to 3, like that of alfalfa hay, it is termed narrow, and 1 to 20, as in corn-stalks, is termed a wide ratio. In compounding rations for the various feeding purposes upon the farm, it is usually more difficult to procure the necessary amount of nitrogen or protein than to procure the carbohydrates and fat. This latter fact brings into prominence leguminous plants, for they are all naturally richer in protein than cereal grains and hay from grasses; besides, the legumes get their nitrogen largely from the air, while all other plants draw their nitrogen from the soil.

Table of analyses of farm products.

Feeding materials.	Dry matter.	Digestible nutrients in 100 pounds.			Fertilizing elements in 100 pounds.			Nutritive ratio.
		Protein.	Carbohydrates.	Ether extract.	Nitrogen.	Phosphoric acid.	Potash.	
	Per cent.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Corn, all analyses	89.1	7.9	66.7	4.3	18.2	7.0	4.0	1: 9.8
Corn and cob meal	84.9	4.4	60.0	2.9	14.1	5.7	4.7	1:15.2
Gluten meal	91.8	25.8	43.3	11.0	50.3	3.3	0.5	1: 2.7
Wheat	89.5	10.2	69.2	1.7	23.6	7.9	5.0	1: 7.2
Wheat bran	88.1	12.2	39.2	2.7	26.7	28.9	16.1	1: 3.7
Wheat middlings	87.9	12.8	53.0	3.4	26.3	9.5	6.3	1: 4.8
Barley	89.1	8.7	65.6	1.6	15.1	7.9	4.8	1: 7.9
Oats	89.0	9.2	47.3	4.2	20.6	8.2	6.2	1: 6.2
Buckwheat	87.4	7.7	49.2	1.8	14.4	4.4	2.1	1: 6.9
Buckwheat bran	89.5	7.4	30.4	1.9	36.4	17.8	12.8	1: 4.7
Buckwheat middlings	87.3	22.0	33.4	5.4	42.8	21.9	11.4	1: 2.1
Millet	86.0	8.9	45.0	3.2	20.4	8.5	3.6	1: 5.9
Linseed meal, old prooess	90.8	29.3	32.7	7.0	54.3	16.6	13.7	1: 1.1
Cottonsed meal	91.8	37.2	16.9	12.2	67.9	28.8	8.7	1: 1.2
Peas	89.5	16.8	51.8	0.7	30.8	8.2	9.9	1: 3.2
Soy beans	89.2	29.6	22.3	14.4	53.0	18.7	19.9	1: 1.9
Cow peas	85.2	18.3	54.2	1.1	33.3	....	....	1: 3.1
Corn stover	59.5	1.7	32.4	0.7	10.4	2.9	14.0	1:20.0
Timothy hay	86.8	2.8	43.4	1.4	12.6	5.3	9.0	1:16.7
Hungarian grass hay	92.3	4.5	51.7	1.3	12.0	3.5	13.0	1:12.2
Soy bean hay	88.7	10.8	38.7	1.5	23.2	6.7	10.8	1: 3:9
Wheat straw	90.4	0.4	36.3	0.4	5.9	1.2	5.1	1:93.1
Oat straw	90.8	1.2	38.6	0.8	6.2	2.0	12.4	1:33.8
Red clover hay	84.7	6.8	35.8	1.7	20.7	3.8	22.0	1: 5.8
Alsike clover hay	90.3	8.4	42.5	1.5	23.4	6.7	22.3	1: 5.5
Cow pea hay	83.9	10.8	38.6	1.1	19.5	5.2	14.7	1; 3.8
Alfalfa hay	91.6	11.0	39.6	1.2	21.9	5.1	16.8	1: 3.9
Soy bean straw	89.9	2.3	40.0	1.0	17.5	4.0	13.2	1:18.4

In determining the value of a crop for green manuring, we look to its bulk of vegetable matter, the quantity of mineral matter it will dissolve from the coarser particles of soil, and the amount of organic nitrogen it will assimilate from the soil and atmosphere. Here the legumes display their prominence, largely through their drought resisting qualities due to an enormous root system and their root tubercles, which convert the free nitrogen of the air into forms assimilated by living plants.

Prominent among the legumes of recent introduction are the cow pea, soy beans and winter vetch, although their special characteristics are found in a general way, though not so marked, among the clovers, lucernes, peas, beans, etc.

Interesting results showing comparative yields of these crops are found in Nebraska Experiment Bulletin No. 93.

In growing legumes, numerous experiments have been tried to show the value of inoculating the soil with germs from a field where the special crop has been previously grown. These trials have met with indifferent success, though generally on new ground the introduction of a special bacteria has been followed with marked increased yield. Dugger, Alabama Experiment Station Bulletin 87, found soil inoculation to increase the yield ten times. It is found, however, that the most of our soils contain the proper bacteria and that inoculation is unnecessary.

Experiments to determine the digestibility of cow peas, either as green feed, silage or cured hay, show it to rank higher than the average of forage crops. The winter vetch is slightly more digestible than cow peas, and soy beans more than the vetch.

COW PEAS.

(*Vigna catjang.*)

The cow pea (*Vigna catjang*) is a native of the southern states, resembling in its habit the field beans, and is grown for forage, either dry or green, and for green manure. Until recent years this plant remained in its native home, the southern states, where frosts were seldom and the season was sufficiently long for a tender plant of this nature to reach mature growth. It has been gradually acclimated to northern latitudes until now there are a number of varieties which will mature their seeds in the northern counties of southern Michigan. This acclimating process has resulted in decreasing the growth of foliage. When a cow pea seed of a rank growing variety is brought from its native soil to the latitude of Michigan, it makes its enormous growth but gives little promise of developing seeds. This plant is used in the south as feed for all kinds of farm animals, and in all forms. . It is even employed somewhat as human food in either the green or ripe state. As food for live stock it is used for pasture, is made into hay, baled and sold in the market as timothy and clover is in the north, and the seeds are ground and fed as grain. Owing to its being readily killed by the slightest freeze, it must be grown between the periods of late spring and early fall frosts, provided one wishes to raise seeds or grow the crop for hay.

The ground for cow peas should be prepared as carefully as for any garden crop by thoroughly plowing, rolling, harrowing, etc., fitting the ground to perfect condition about the last of May. The seed may be sown broadcast, in drills or in hills. If the ground is very rich and has been so carefully cultivated that there is no danger of weed seeds growing, it will be safe to sow broadcast, otherwise, owing to the fact that the seeds grow slowly at first, it is perhaps better to sow them in hills or drills in order that they may be cultivated once or twice to keep down the weeds and keep the surface mellow until the plants have acquired sufficient growth to partially shade the ground. The rows may be any convenient distance apart, between 18 inches and 2½ feet. Even three-foot rows would provide sufficient growth to completely cover the ground long before the end of the season. If the seed is sown broadcast, it is possible and perhaps wise to cultivate once or twice with a weeder. The use to which the crop is to be put will determine the method of harvesting it. If cured for hay, it had best be cut with the mowing machine and handled like clover hay, being careful to avoid much stirring in the hot, dry sun, which will shake off many of the leaves. Even the haying machine, however, will not gather all of the growth, as the vines remain close to the ground, but no one should begrudge the soil a few of the stalks and leaves of this valuable fertilizing crop. The period of the year, however, when the cow pea crop is ready to make into hay is not good haying weather, so that where the silo is available, it would perhaps be fully as well to store them there in connection, possibly, with the corn silage. A number of experiments have been tried showing remarkably good results from planting cow peas with the corn crop, growing a mixed feed of corn and legume, making a quality of silage much richer in protein. Experiments at the Tennessee Experiment Station* have shown very interesting results from this method. Mr. A. M. Welch of Ionia, Mich., has given this method a complete trial, and is thoroughly convinced that by growing cow peas with his corn he can get the best possible quality of silage for dairy cows.

According to Farmers' Bulletin No. 89, the feeding value of cow peas is equal to that of the best red clover, and the hay ranks high in palatability and digestibility. As a pasture, it is claimed that an acre will supply fifteen or twenty hogs for an entire fall. According to Duggar, Alabama Experiment Station Bulletin No. 82, the results generally favor cow peas and show them to be superior to bran.

---

* University of Tennessee Year Book for 1901.

In Illinois Experiment Station Bulletin No. 43, Hopkins says cow pea hay corresponds closely to clover hay. The clover hay has more fat, but as cow pea hay is more digestible and has more protein, its total energy is higher than that of clover hay.

The cow pea is meeting with favor among horticulturists as a winter cover crop for orchards. For this purpose it is sown in the middle of the summer and allowed to die down and lie on the ground during the winter, when it becomes thoroughly rotted, and can be readily worked into the soil in the spring.

Mr. B. E. Rickert of Lowell, Mich., says regarding his experience with cow peas:

"I grew them two years ago, for seed only, on a field where the soil was sandy, heavy, black and quite clayey; the subsoil is clay. They made a large growth. The yield of seed was 25 bushels per acre. I planted them in rows 30 inches apart so I could cultivate. The variety was the Whip-poor-will.

"This last season I planted them with the corn for the silo, and was not very successful, but I will try again this year.

"I have not tried them as pasture, but think they will be good. They seem to be a great root fertilizer. The stock eat the vines and pods and relish them."

Mr. T. T. Higgins of Dailey, Cass county, sowed Whip-poor-will cow peas on May 22 in drills 28 inches apart on sandy clay and gravelly loam. The vines grew from three to five feet in length, almost covering the ground, and ripened before the frost. He pulled and threshed them, feeding the stock the stalk, and although very dry, they ate it with relish.

Mr. E. F. Diehl of Leesburg, Ind., writes regarding cow peas and soy beans as follows:

"My four years' experience with cow peas has been in conjunction with soy beans, and find both valuable, the one fitting certain conditions and purposes better than the other, and thus far have grown them principally for their seed, but their pasture and forage value have been thoroughly tested with all kinds of stock with good results. Soy bean plants are relished as soon as they appear above ground; cow peas not so well until they reach a degree of maturity indicated by the ripening of the earliest pods, and this, I believe is the best stage for pasture, hay, soiling, silage and fertilizer. The threshed straw is much relished by stock in winter when straw and corn-fodder is the principal roughage (this is equally true of the soys). On poor soils, cow peas will thrive better than any other legume that has a forage value, and is among the best, if not the best, to resist drought when not planted too thickly, due to its extensive root system and vines carrying a dense foliage. The cow pea bacteria seem to be present in all soils. I have found them in bunches larger than their seeds (peas), and on roots six feet from the stem as large as grains of wheat. This fact, with the quick growth of vines and leaves protecting the ground from beating rains and hot suns, makes the early varieties preeminently catch crop fertilizers for the north, furnishing more humus material and fixing more atmospheric nitrogen in the soil in a shorter time than any other legume, especially in a dry season and on poor land.

"If cow peas are planted this far north about the first of June, the early varieties will be right to turn hogs on the last half of August and will furnish the right food at this time to finish on new corn, and the ground may be seeded with winter wheat afterwards without any preparation, if a disk drill be used, or rye may be seeded for a green winter cover crop and turned under for spring crop, especially potatoes. For beginners, would advise: Get seed that will mature in your latitude, or farther north, drill 15 pounds per acre in rows 30 to 36 inches apart, and cultivate clean until vines interfere. A few years' trial with cow peas will suggest many ways to utilize them to good advantage on every farm."

Maj. Geo. K. Newcombe, Traverse City, Mich., writes of his experience on "Orchard Knob" farm, situated on Traverse peninsula, fronting the west arm of Traverse bay. The farm was badly run and lacked in humus and soil fertility, especially on the hilltops. After trying red clover and field peas with more or less success, he writes:

"We tried Black Eye cow peas on an acre of old orchard standing on the first bench of land along the bay shore, an old beach. We planted in drills with plenty of seed. Result, a crop too heavy to cover with a plow alone. The next experiment, hardly an experiment, either, was on a larger scale. We used 10 bushels of seed broadcast on 10 acres of young orchard. This practice we have continued whenever most needed until last year. The season was so cold and backward that we planted only a few bushels of seed which we had left or gathered from our crops. As our place was then all covered with clover, except one half-acre parcel in potatoes, the result was quite satisfactory.

"We have never used the cow pea for forage because we wanted it all for renovator.

The plant always ripens its seed on our place. We have tried other legumes, and have dropped all but vetches, peanuts, alfalfa, crimson, June and alsike clovers, field peas and cow peas."

The following letter from a St. Joseph county farmer gives a valuable experience with cow peas:

"The growing of cow peas is no longer an experiment with us in southern Michigan. I have grown them for five years, from 10 to 70 acres each year, average about 30 acres. Seeding should be done about first week in June, never before the ground is thoroughly warm, so as to germinate quickly. Sow with any drill that will sow beans, with all the tubes open, about one bushel per acre. They soon cover the ground and keep all weeds down, if plowed, say the fore part of May, with a good cultivating before sowing. The effect upon the ground is most marked, leaving it very mellow and lively, so to speak. Some sow in rows as beans when seed and peas is an object. Have had good catch of clover sown on wheat stubble plowed and sown in August. Wheat was sown after cow peas; also corn does well after peas. When cut for hay, cure same as clover about first week in August; if threshed, cut just before frost, it then makes about as good feed, and hay will keep better. There is nothing better than this hay and shredded stalks for milch cows, thus saving bran. Hogs also grow remarkably well by turning them on in August, and they live there until snow comes if they have some kind of green feed. It also makes good pasture for any stock, if not turned on too green.—Geo. Engle, Centreville, Mich."

Below is a letter from Mr. R. M. Kellogg, Three Rivers, Mich., giving his experience with cow peas:

"In the spring of 1896 I sowed 35 acres of Mammoth Clay cow peas, using one and a half bushels to the acre, sown broadcast with an ordinary grain drill. The soil had been much run and was especially destitute of humus. The season was wet and they made a very large growth, completely shading the ground and smothering the weeds.

"The ground was literally filled with nodes and roots after the first of August, and very little of them before that time. A part were plowed under before frost struck them and a part late in October, while some were left until spring. In the following crop, as well as in texture of soil, I could see a marked difference in favor of those which laid on the top of the ground all winter. The soil was made mellow and the surface crust very much less firm and brittle.

"The next summer I used the Mammoth Black and a dwarf variety. The season proved very dry and little growth was secured. The dwarf shaded the ground very little and weeds took possession of the ground.

"The next year 40 acres of Whip-poor-will were sown which, although the season was dry, made a fair growth and ripened considerable seed, although it hardly paid to gather it.

"The results of my experience convince me that the cow pea is to be an important factor in bringing up our land, so that we may again use the clovers. What we must have is humus and mineral elements, so that the clover shall secure a rootage before the drought sets in.

"When sowing the peas, in each case I drilled in with the seed 300 pounds of fine ground bone and spread about 25 bushels of wood ashes to the acre, which I am sure had a marked effect on the growth of the plants.

"I am satisfied that all dwarf varieties should be discarded and that no attempt should be made to grow the seed in Michigan. Use only the Mammoth Clay and Wonder pea and sow about the first of June, one and a half bushels to the acre, using the mineral fertilizers and leaving the vines on the ground unmolested until the following spring, when they will be decayed enough to break up and be mixed with the soil by plowing and harrowing."

SOY BEANS.

(*Glycine hispida.*)

The name Soy bean is used more commonly than Soja bean, although either is correct. The Soy bean came originally from Japan in the early part of the last century, but has received no particular attention in this country until within the past dozen years. It has, however, a more extended reign in the northern states than the cow pea, being a little more hardy and ripening its seeds in a shorter season. The Soy bean grows in an upright branching stalk from one to three feet high. The growth of leaves is quite luxuriant. They are irregular in shape and drop off when the plants become ripe. The numerous pods are flat, brown and fuzzy, containing from two to four seeds. The beans are flattened, round, about the shape though smaller than the navy bean, and vary in color according to the variety. There are a great many varieties of this plant, from the dwarf which grows short stalks, bearing great quantities of small seeds, to the long branching sorts having a tendency to climb, and which do not produce their seeds in northern latitudes. The Soy bean will grow well on any of our Michigan soils, although it responds to good soil, moisture and favorable conditions for growth. On light sandy soil it developes an immense growth of root tubercles and will make a growth far in advance of any non-leguminous plant. If given a good supply of moisture during the first six weeks of its growth, it will withstand and continue to grow vigorously during the severe summer drought. It, like the cow peas, should be sown after the danger of spring frosts, and will probably give the best returns when sown in drills, with the seeds dropped singly about three inches apart, the rows being from two to two and a half feet apart.

Mr. Edward E. Evans of West Branch, Mich., who has been growing Soy beans for green manure, forage and seed, writes regarding their culture as follows:

"On rich soils cow peas and true peas run to vines, producing very little seed. On such soil the Soy produces a proportionately larger crop of both plant and seed. In growing Soys the same general rules that apply to white field beans should be followed. It must be borne in mind, however, that Soys form their first pods about four or five inches from the point at which the seed was planted. For this reason they should be covered only deep enough to insure germination. They can be planted with a corn or bean planter, or grain drill. I use an Empire drill with bean attachments, planting three rows 28 inches apart. The ideal Soy bean planter will drop single beans three or four inches apart. This seeding will require eight to sixteen quarts per acre, varying with variety and size of beans."

The cultivation for the crop should be done as much as possible before the seed is sown. Owing to the fact of the lateness of seeding, which should occur not earlier than May 15, and with favorable conditions for growth can be delayed until the middle to the last of June, this preliminary cultivation can be made very effectual in lessening the slower work of cultivating the growing crop. The energy of the crop during the first six weeks of its growth appears to be devoted to establishing a good root system to carry it through the summer drought. Two or three cultivatings will generally suffice. The weeder can be used to advantage until the plants are too high to pass under the frame. After this time, the plants grow so rapidly that they soon have such complete possession and so thoroughly shade the ground as to require no further care.

The method of harvesting the crop will depend somewhat upon the use to which it is put. If to be used for soiling, it may be cut with the mowing machine or scythe as soon as the pods begin to appear. For the silo, it will be better to give the plants time for complete growth, though not allow them to reach the mature state, when the seeds will become hard and liable to shell. This would also be the time to cut for hay. If grown for seed, it is better to allow the crop to ripen and drop its leaves. The straw, of course, when the crop is about to mature, as will be seen in the table of analyses, will be of little value as feed. Mr. Evans writes in regard to harvesting as follows:

"If for seed, the crop should be harvested when most of the leaves have fallen off, preferably in damp weather to avoid shelling. A week of rain will not injure the beans. * * * For soiling, they may be cut at any time after the pods commence to form; for the silo, when pods attain their full size, but before they harden. Most varieties can be harvested with the bean harvester, but it will be found necessary to keep the shears sharper than for common beans. The mower can be used, but the reaper is much better. In cutting for ensilage, the self binder is the best machine, and it is easier to handle the crop and run it through the cutter."

There are a great many varieties of Soy beans and their number is gradually increasing. Unfortunately, the naming of varieties of this new plant has become badly mixed. There are a number of different sorts which will thrive well in our Michigan latitudes. Until the names of the several varieties are more definitely fixed, it will perhaps be best for the Michigan farmer to buy seeds produced in Michigan and learn, in a small way by his own experience, the varieties best adapted to his soil and conditions.

Nearly all the dwarf varieties mature their seeds in this State, but they grow only a small quantity of vine. The Early Yellow Soys, if true to name, will also ripen seeds in the southern half of Michigan. The Medium Green, under favorable conditions, will ripen in the central and southern part, while the Early Black will require a little longer season. Attempts to ripen the Soys by planting early are generally unsuccessful, because the plants will not make a healthy normal growth until the temperature has reached a certain degree. It, therefore, results that early planting simply prolongs the period of growth, and it is better to delay the planting until after the 15th of May and give the ground the benefit of a longer period of thorough cultivation instead of an unnecessary long season for the plants to grow.

Feeding Value of Soy Beans.—Mr. G. W. Buckalew of Allen, Hillsdale county, Mich., writes as follows:

"I have been feeding Soy bean-meal to veal lambs this winter, and find they never did better than they are doing now. I use less oil-meal and bran than usual. Have come to the conclusion that the beans take the place of both to a large degree. If this is true, why would it not be policy for farmers to raise them and save expense of buying oil-meal and bran?"

Mr. Walter Vetterly of Battle Creek, Mich., has been feeding one quart of Soy bean-meal with about three times its bulk of corn and cob-meal and oats to his milch cows. Upon removing the feed of Soy beans there was a decided shrinkage in the flow of milk.

Five samples of Soy beans were analyzed by the chemist of the Experiment Station this season, resulting as follows:

	Carbohydrates	Crude protein.	Ether extract.	Crude fibre.	Moisture.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Extra early black	29.99	29.99	20.44	3.85	10.77	4.94
No. 2 medium early green	27.17	34.39	18.67	4.59	10.10	5.07
No. 3 medium early black	25.74	37.27	18.79	3.89	9.61	4.69
No. 4 Ito San or medium early yellow	24.83	41.04	15.74	4.40	9.50	4.48
Medium early yellow	24.45	41.52	17.72	4.53	6.15	5.63

Mr. T. T. Higgins of Dailey, Cass county, sowed Soy beans, using two bushels of seed on four acres. Sowed in rows 36 inches apart with shoe drill. Cultivated only once. Threshed with flails, but didn't try to get all the seed. Cut the last of August, raked and let lie in windrow until dry, then put it in the barn.

He says: "Although perfectly ripe and dry when cut, and the straw very woody, the cattle and horses eat it all up with as great a relish as I ever knew them to eat clover hay."

Mr. A. M. Todd tried Soy beans on his muck farm at Pearle, Allegan county, getting enormous growth of plants, but practically no mature seeds.

Mr. John Dunning of Cassopolis sowed Soy beans on light clay loam soil on June 5. The seed was sown in drills 30 inches apart, the same as white beans. Stood the hot weather better than the cow peas. Sowed one-half bushel on one-half acre and threshed 10 bushels of seed.

Considering the high protein and fat content of the Soy bean seed, together with its high digestibility, it seems quite probable that this plant will be grown for its grain to balance up the more highly carbonaceous foods produced upon the Michigan farms. The yield of seed per acre ranges from 10 to 30 bushels. Where the seed has been used in the grain ration, it is generally ground, and the ground Soy bean-meal seems to be serving as a substitute for the cotton-seed and linseed-meal. Massachusetts Experiment Station Report for 1893 gives an account of an experiment where Soy bean-meal proved superior to cotton-seed-meal for milch cows.

In Kansas Experiment Station Bulletin No. 92 five experiments are recorded giving the results of feeding hogs of different ages rations of four-fifths Kafir corn-meal and one-fifth Soy bean-meal, wherein the advantage from adding the one-fifth Soy bean-meal made savings of between 13 and 37 per cent of the feed consumed. This experiment advises to mix just before feeding and not to soak the meal very long. In speaking of Soy bean-meal as a feed for cows, the Kansas Experiment Station Bulletin states that it "will take the place of linseed-meal, being somewhat richer in protein, a laxative feed, which softens the butter. Not over three or four pounds per day should be fed to each cow. Soy bean vines fed green make good milk producing food, though no stock likes the fodder after ripe beans are removed."

One or two writers have noted that the Soy beans are sometimes destroyed by rabbits. While in some localities this might be a serious objection, the fact suggests a possible value of the Soy beans as feed for domestic rabbits and hares.

WINTER VETCH.

(*Vicia villosa.*)

This interesting legume has appeared under a great variety of names. It is often called hairy vetch and sand vetch. Some have called it Russian vetch, probably because it originated in Russia.

The seeds of this plant are small, black, hard spheres, resembling sweet pea seeds. The growing plant also bears a close resemblance to sweet pea up to the time it blossoms, when a field of vetch appears as a sea of beautiful bluish-purple clustered flowers. The plant is a branching, climbing vine, a great many of its branches attaining the length of 7 to 10 feet.

A full grown crop even in three foot rows forms a dense mat completely covering the ground to the depth of one to two feet. When grown with a crop of wheat, rye or other strong growing plant, it is kept entirely above the ground.

If the seeds be sown in early spring, when the ground is moist and the conditions generally favorable for growth, the plant will develop rapidly. By the middle of August, it will be in full blossom, although it will continue to grow and remain green until the ground freezes in the winter. A few seeds will be formed in the late fall, but spring sowing is not advisable if one wishes to harvest a crop of seeds.

If the seed is sown in the fall, that is, any time between the first of August and the first of October, it will make some growth before winter sets in, but in the following spring will continue a marvelous growth, developing blossoms by the first of June and ripen seeds by the middle of July. The fall sowing is the more desirable for producing seeds. One of the principal objections urged against the growing of this crop is the great expense for seeds which are this year quoted at about $7.00 per bushel, while former advices have recommended using as high as a bushel and a half per acre. We find that the seed can be readily grown in this State by sowing in the fall, and harvesting about the time of winter wheat.

It is found too that the quantity of seed necessary can be economized by sowing with some other crop. A mixture of half oats and half vetch for spring seeding and a similar mixture of wheat or rye with the vetch for fall seeding have proved to be successful combinations for soiling and hay. Our observation leads us to recommend the use of winter wheat instead of rye for fall seeding, because the latter will ripen too early and not give the vetch sufficient time for mature growth. When sown with winter wheat for hay, the crop makes an excellent substitute for red clover and is ready to harvest as hay by the middle of June. A piece of this on light sandy loam soil on the College farm the past year from a seeding of one-half bushel Dawson's Golden Chaff wheat and one-half bushel winter vetch gave on June 19th 4300 lbs. of cured hay to the acre. The hay was greedily eaten by all kinds of farm stock, and its feeding value was especially high as will be seen by the following analysis:

Moisture 17.70, Crude Protein 12.47, Ash 5.72, Ether Extract 2.20, Crude Fibre 24.47, and Carbohydrates 37.42.

Circular No. 6, Division of Agrostology, recommends ensiloing it in alternate layers with corn. Considering its high protein content, this practice certainly ought to be desirable. A yield of nine tons of green feed per acre is recorded in Circular No. 20, Division of Agrostology.

In Alabama Experiment Station Bulletin No. 105, hairy vetch is recommended as an especially valuable forage plant for the south. Analyses were made at various stages of growth, resulting as follows:

Yield and composition of Hairy Vetch cut at different dates.

(Alabama College Station Bulletin No. 105.—J. F. Duggar.)

Date.	Stage of growth.	Hay.	Composition.					
		Yield per acre.	Moisture.	Crude protein.	Carbohydrates	Fat.	Crude fibre.	Ash.
		Pounds.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Apr. 19	Just before blooming...	3,117	20 72	23.45	26.25	2.22	20.24	7.12
Apr. 26	5% bloom showing.......	3,705	22.83	18.97	29.06	2.11	20.44	6.59
May 2	In full bloom............	5,789	20.30	17.15	32.12	2.14	22.50	5.79
May 9	Seed pods formed but not filled...............	5,463	22.48	18.71	29.50	2.35	19.92	7.04

The analyses of vines, roots and stubbles to determine the fertilizing value develop the fact that the nitrogen content increases with the stage of maturity, while the percentage of potash and phosphoric acid changes but little as the crop matures. These results, however, do suggest the advisability of postponing plowing under the crop for green manure until as late in the life of the plant as practicable.

The winter vetch is rapidly gaining favor as a cover crop for orchards. For this purpose it should be sown in July or August and if the seeding is followed by favorable growing weather, a very satisfactory crop will be present to mulch the soil when winter sets in.

Mr. E. W. Hutchinson of Shelby, Mich., has for several years grown winter vetch for various purposes and writes as follows:

"I would say that with us winter vetch can be grown successfully either for seed or as a feeding plant, or for plowing under as a fertilizer, and when sown on good corn or potato ground, it will grow a big crop. I have seen a space of six foot square covered with the vines from one root.

"If sown in early fall, it will be ready to commence to cut in early summer for green feed, and if cut when it begins to bloom, or is in full bloom, and is not cut too close, it can be cut as many as three times.

"Should it be wanted as green feed for late fall or early spring, it should be sown in the spring, but should it be wanted for seed or dry feed, it should be sown in the fall. Should it be wanted to feed as hay, we find it is well to sow about twelve pounds of rye and fifteen pounds of vetch seed to the acre, but when the vetch is sown alone, we sow about twenty pounds per acre. By sowing rye with the vetch, it holds it up the better, for cutting and curing. We find it one of the best plants for sowing on light land to plow under.

"I do not just remember how much seed we got per acre, but I do know that it was a good paying crop at the price we had to pay for seed, viz: $4.00 per bushel."

Mr. C. H. Estes, Bates, Mich., in giving his experience with winter vetch pronounces it one of the most promising new legumes for northern Michigan. As a substitute for red clover, he believes that it is a success. His most interesting experience with it was from some seedings made in the spring which he used for fall pasturage. Some of the plants which were left through the winter were found in the spring showing above the snow and his cows when offered them although having had roots once a day all winter, would eat this vetch in early March, seeming to like it. Even the fowls relished this green feed in the early spring.

Mr. Jas. Mills of Mancelona, Antrim county, sowed some winter vetch on sandy soil broadcast May 1st, 1901. He writes: "I tried it for green manure (top dressing) in orchard. It commenced to bloom in August and continued until frost in the fall, and there was a good covering on the land at the end of the season. It did not, however, seem strong enough to withstand the June grass."

SOME INSECTS OF THE YEAR 1901.

BY RUFUS H. PETTIT.

Bulletin 200—Entomological Department.

INTRODUCTORY.

The aim of the present bulletin is to give short accounts of such insects as have attracted special attention during the summer of 1901, together with advice as to remedial treatment. Many other insects have been present and have done injury but such only were selected as had not recently been noticed in the bulletins of this office.

Correspondence relating to injurious insects is desired, and all aid and advice in our power will be at all times freely and gladly given upon application. The best means we have of finding out the needs of the farmer is through the letters sent us asking for advice in regard to specific insects. In writing for information, it is always best to send one or more of the insects in question or some of their work. A piece of the insect itself is usually more valuable than a lengthy description, and in sending specimens, the best way is to enclose them in a tight tin box, with few if any air holes (insects require much less air than we do). Together with the insects themselves it is well to enclose some bits of the natural food for their use on the way. Always label the package with the name of the sender to avoid confusion, as we often receive many boxes at a time.

Never dip specimens in kerosene or other insecticide before sending; in case of scales, put them in a tight tin box.

In sending insects or their work, always address to the Entomologist of the Experiment Station, Agricultural College, Mich.

The writer wishes to extend his thanks to Dr. L. O. Howard, Mr. Theodore Pergande, and Mr. Kotinsky, of the Entomological division of our National Department of Agriculture; and to Prof. E. Dwight Sanderson, of the Delaware Experiment Station, for determination of specimens; to Prof. M. V. Slingerland, of the Cornell University Experiment Station, and to Mr. V. H. Lowe, of the New York State Experiment Station at Geneva, for Coccid material; and to the many fruit-growers and farmers who have furnished material for study, often at the cost of considerable trouble.

THE APRICOT SCALE ON PLUM.

(*Lecanium armeniacum* Craw.)

The past season has marked the first semi-serious outbreak of the western apricot-scale in Michigan. This scale is thought to have been present in the eastern part of the United States for some time, possibly having been introduced from Europe or from the west. In California, it has committed ravages among the apricot orchards, acquiring by reason of this, the name "apricot-scale." As will be seen a little later on, this pest does not confine its operations to apricot trees, but in the East is more prone to attack plum and grape. The work in Michigan has not been serious enough to warrant any great misgivings, being confined to comparatively few trees; it is, however, a pest that will bear watching and checking whenever and wherever it becomes numerous.

The apricot-scale belongs to the Coccidæ or scale-insects, like the San Jose scale and the English-walnut scale, but its appearance is markedly different from these two species. The individual insects are very many times larger and are not protected with papery coverings. The full grown females are yellowish-brown marked with black when just grown, later turning dark brown and being covered with a powdery or cottony material which resembles the bloom of a plum. They are hemispherical in form,

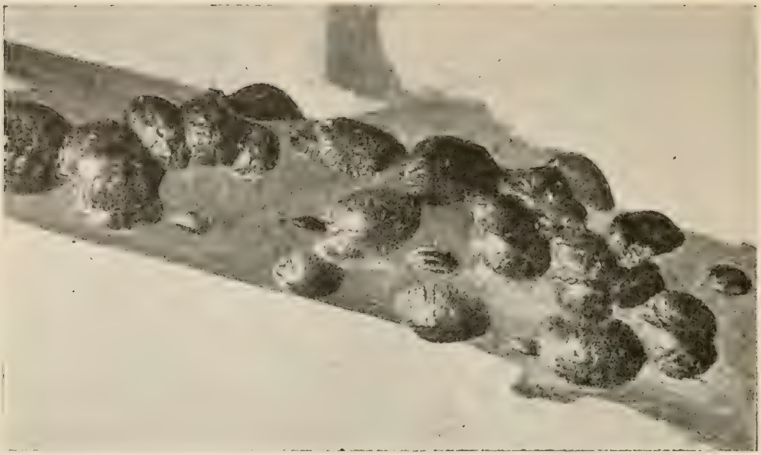


Fig. 1.—Apricot Scale *Lecanium armeniacum* on plum. Females full grown but still soft. Photograph enlarged 4½ times from original.

sometimes slightly elongated, becoming hard and horny after death. The eggs are laid inside the horny skin or shell, the body of the mother shrinking away to make room for them. Thus the skin or shell of the mother becomes really a basket for holding the eggs until they hatch and the young lice crawl out and find suitable places to grow. The males, as explained further on, are quite different from the females, being winged, much smaller, and more delicate.

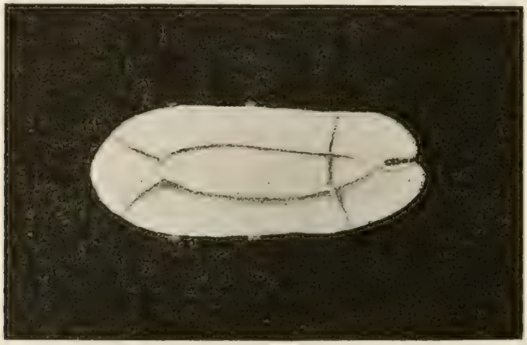


Fig. 2.—Apricot Scale *Lecanium armeniacum.* Scale of male greatly enlarged. Original.

The apricot-scale is surely a serious pest and should be treated as such. It has been recorded from New York, Connecticut, Massachusetts and Ohio, though it has thus far failed to justify in the East, the reputation that it holds in the West. Most of the damage that has been done in Michigan is in the northern part, though it has been received from other regions, and probably will be found here and there over the State on plum trees and on other hosts.

ITS LIFE HISTORY.

On the 27th of April, specimens were received of both males and females, living and in normal condition. The female insects had then molted for the last time, but were only a little over ⅛ of an inch in length (2 mm.). Many of the males were just getting ready to emerge, some of them showing the long tail filaments. The males emerge in May, some probably running over into June. The females grow very rapidly attaining full size by the latter part of May. Specimens received on May 24 from the same source, showed the females nearly full-grown but still soft and fleshy. By the middle of June most of the eggs had been laid and some had been hatched. By July 15 all or nearly all of the eggs had been hatched.

After emerging from the egg, the young wander about for a few hours or days, and then select some place, usually on the under side of the leaves near the large veins, where they quietly settle down and grow. Here they remain until the latter part of August, when they migrate back to the twigs, the majority getting back to safe permanent quarters by the end of September, as the leaves are falling. Here they remain, moving about but little for the remainder of their lives.

During the winter and early spring they are quite small and not protected by the hard, horny shell, so this is the favorable time for spraying. The leaves having fallen, the surface to be sprayed is reduced to the lowest terms and the scales themselves are crowded together as much as ever they will be.

The males, unlike the females are not fixed in the adult condition to one spot. During May and possibly in early June, these delicate little creatures crawl out from under their waxy shells and meet the females, dying soon afterward. In common with all the Coccidæ, the males are dainty two-winged insects whose second pair of wings is replaced by a pair of elbowed bristles having hooks at their distal extremities. These hooks fasten into corresponding loops in the wings, and the motion of the bristles being transmitted to the wings, flight is aided thereby. In place of the mouth-parts are a second pair of eyes.

The scale of the male is a delicate waxy affair, pure white and almost trasparent. It is about ⅛ of an inch long and less than half as wide. About one-fourth of the length of the scale from the caudal end is a transverse ridge, and on the central elevated region is a ridge forming a long oval extending lengthwise of the scale and enclosing less than one-third its width. From each side near the cephalic end of the oval, there extend to the margin of the scale, single ridges. At the caudal end is a deep cleft, the anal cleft, extending nearly to the oval ridge. Unfortunately the writer was unable to study the males themselves at the time when they emerged.

THE FEMALE.

On the 24th of May, 1901, the females were, some of them, almost full grown, but all were soft as yet. They were from one-eighth to three-sixteenths of an inch (3-4 ½ mm.) in length, and from three thirty-seconds to one-eighth of an inch or a little more (2-3 ½ mm.) broad by about one-eighth of an inch more or less (1-2 mm.) high, yellowish or brownish marked with black.

At this time there is a light yellowish longitudinal stripe, which disappears with age, and running transversely or somewhat radially toward the cephalic and caudal extremities are about nine black ill-defined lines which often merge just beside the central yellowish stripe. In the younger scales there is a slightly elevated ridge running longitudinally and coincident with the yellowish stripe. There are also slightly elevated ridges or wrinkles coincident with the black stripes. These wrinkles become more marked on the sides than in the central region. As they become nearly full-grown a fine cottony pruinose deposit is made over the entire scale. Younger scales are entirely naked. Older scales are shiny, covered with a cottony pruinose deposit, (until weathered off) and usually oval. In cases where the scale has room, it may be quite perceptibly extended behind, but when crowded it grows more rounded or oval and strongly elevated. The lower edge sometimes flares slightly but more often the sides are bulged out. The surface is distinctly pitted and irregularly wrinkled on the sides. The anal cleft is deep and the anal scales not prominent though plainly visible.

When prepared and studied under the microscope, the young female is seen to have a test thin and transparent, with suggestions of thin spots that afterward become quite conspicuous. As the female becomes older, the mesal angles of the posterior lobes become chitinized. This thickening spreads around the entire border and then over the dome. In older specimens the test is yellowish-brown, opaque with numerous small round pores of a thinner nature which appear in the boiled specimens to be thin spots, translucent and nearly piercing the test. These punctulations are more numerous on the sides and are arranged irregularly but still following the lines of segmentation. The test on the dorsum is thinner, in certain cases marked with fine mottlings of lighter color, the light spots irregular in form and separated from one another by lines of a darker tint.

Front leg.—The coxa has two apical bristles and one basal one. Trochanter with one apical bristle; the femur is slightly longer than the tibia, and the tarsus about two-thirds the length of the tibia.

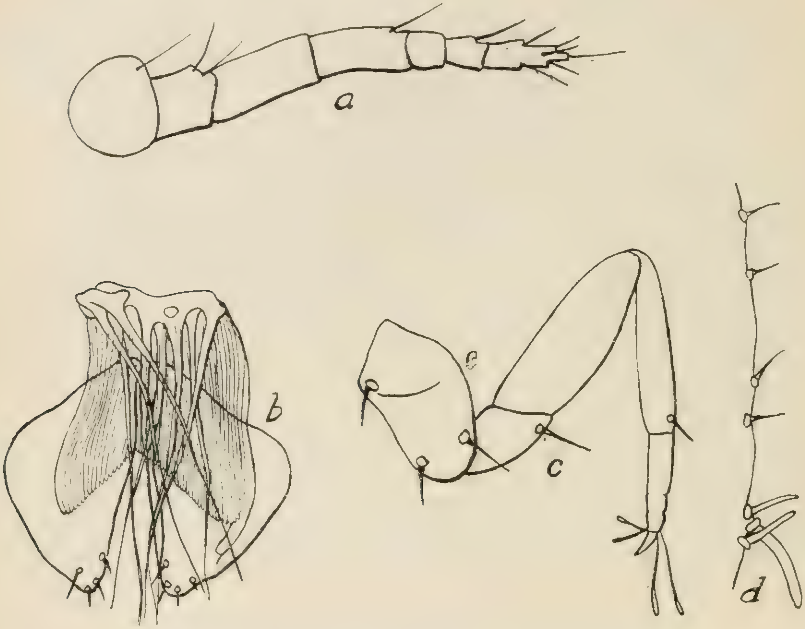


Fig. 3.—Apricot Scale *Lecanium armeniacum.* Female. a, Antenna; b, anal plates and ano-genital ring; c, front leg; d, spines on lateral margin greatly enlarged. Original.

Antenna.—These are seven jointed; joints 3 and 4 about equal; 3 slightly longer than 7; 1 about equal to 2; and 5 and 6 short and subequal, together about as long as 7. In studying a long series of specimens, it was found that no exact formula would hold good throughout the series. Sometimes, as in the case of all *Lecaniums*, the antenna on one side would not correspond with the one opposite. Sometimes joints 3 and 4 would be connate, and sometimes they were so on one side and not on the other. Sometimes the proportions of 5 and 6 would not hold true but there is a certain type to which most individuals conform and from which few depart very far. The specimen figured represents this type as well as any that was seen. The ano-genital ring has eight internal hairs. The anal scales are triangular with four apical short hairs.

ITS NAME.

The name of this interesting species was for some time a question to the writer. Among the species to which it might have been referred were *juglandis* Bouche. *juglandifex* Fitch, which is probably a synonym of juglandis, *cerasifex* Fitch, *rugosum* Sign, *prunastri* Fonsc, and *rotundum* Reaumur. Specimens of the New York plum scale, *Lecanium cerasifex*, from Geneva, N. Y., were kindly sent me by Mr. V. H. Lowe. Entomologist of the N. Y. State Experiment Station at Geneva, and others were sent from Oswego, N. Y., by Prof. M. V. Slingerland, Entomologist of the Cornell Experiment station at Ithaca, N. Y. Prof. Slingerland also sent me specimens from the worst infected orchard in the infestation of 1894. Specimens of *L. cerasifex* determined by Mr. Pergande were also kindly sent me by Dr. L. O. Howard, Entomologist of the U. S. Department of Agriculture, and in my collection are specimens of *L. armeniacum* from California from Mr. Ehrhorn, which are undoubtedly correctly determined.

A careful study of this material and some other at my disposal, seemed to narrow the possibilities down to two species, *L. armeniacum* and *L. cerasifex.* The distinction between these two species is very close indeed. They work on about the same plants. Their life histories correspond closely and structurally they are about as close as could be desired.

Mr. Pergande, whose profound knowledge of this group is known to all, says in response to a letter:

"(*Lecanium armeniacum*) is more readily distinguished from serasifex before hardening of the derm of the full grown female, when the derm is distinctly fasciated and more or less distinctly covered with an easily detached pubescence or threads of wooly secretion. In *cerasifex* the fasciae appear to be wanting and it is also much darker."

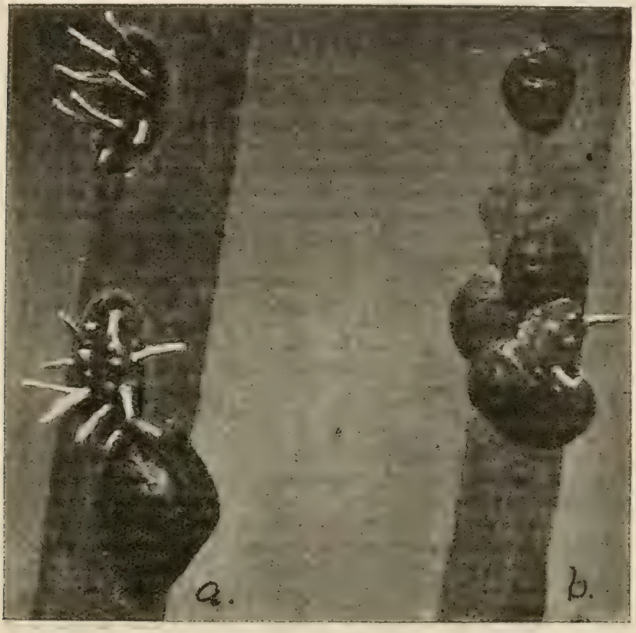


Fig. 4.—Fungus disease of Apricot Scale. a, on *Lecanium* on ash; b, on true Apricot Scale on plum. From photograph enlarged 4½ times. Original.

Of the other related species, *rugosum* has antennæ of eight joints, with joint three longer than the five following (Signoret) *prunastri* has antennæ with six joints, joint three longer than two, four, five and six (Signoret) and with the fourth shortest. In *rotundum* the scale of the male is tuberculous while the species in hand has a male scale quite free from tubercles.

HOST PLANTS.

The writer has found scales that at least structurally resemble the one in question on maple, elm and peach, besides one very similar to it on hackberry. The scale on hackberry differs somewhat from the apricot scale in size, being considerably smaller, but that may be due to the fact that the hackberry has more slender twigs, thinner bark, and is less succulent, thereby affording less nourishment to the scale and consequently a less vigorous growth. The writer was able to find only six hairs in the ano-genital ring in the specimens examined. In order to settle the question, infested branches of hackberry have been placed in plum trees to see whether the scales will migrate to the plum and assume the form of the apricot scale.

In other states the insect has been reported as working on grape, apricot, plum, cherry and Spanish chestnut.

NATURAL ENEMIES.

The parasitic hymenopterous insect *Coccophagus lecanii* was bred from typical specimens of this scale;* and a single scale collected by the writer in the northern part of the State was destroyed by the fungus disease, *Cordyceps clavulata* (Schw.) Ellis.† Fig. 4, b. Fig. 4, a, shows the same fungus on a Lecanium infesting ash, collected in the same county. This fungus is one that attacks Lecaniums on several hosts especially in moist situations.

As has been explained, this species is very closely related to the New York plum scale and this latter scale has been very carefully experimented with and methods for controlling it have been found that have proven successful and satisfactory. It is almost certain that the same methods will prove perfectly satisfactory when used against this scale.

REMEDIES.

Prof. Slingerland was very successful in killing the New York plum scale with a spray of kerosene emulsion applied during the winter months. He used the Riley-Hubbard emulsion diluted four times, spraying very thoroughly and hitting each scale with the mixture. This mixture should not be used under any considerations when the leaves are on the tree as it is likely seriously to injure the tree. The latter part of winter or very early in the spring is the best time to use it, choosing if possible, a bright sunshiny day with little or no wind.

There is a time, during the first half of July, when the young scales are moving about, just after hatching, at which time a weaker spray, emulsion diluted perhaps nine times, may be applied with some benefit, but the amount of work and material necessary at this time is greatly in excess of that required for winter spraying. In July, the young scales are spread over the leaves, and as each one must be hit to be killed, many escape. During the winter months, when they gather on the branches, it is far easier to reach them.

Mr. V. H. Lowe also found this to be true as stated in his MSS. work on the N. Y. plum scale.

No doubt a treatment during the winter months with whale-oil soap applied as for the San Jose scale, would prove effective, but whale-oil soap is much more expensive than the emulsion, and furthermore it is liable to be injurious to the fruit buds, especially so if applied early in the season. In case the infested orchard is a large one and the owner has a pump known as a mixer, one that draws kerosene from one tank and water from another, mixing them as they pass through the pump, it may be found expedient to use this. There is an element of risk in using a mixer on stone fruits but in case of a pest like the one in hand, it sometimes is thought worth while to run a little risk. In no case use the mixture stronger than 20 per cent and take samples of the liquid from time to time in order to measure the amount of oil after allowing it to separate out and rise. This will give a check on the machine.

Following is a list of some of the more important papers on the New York plum scale and the apricot scale:

The Apricot Scale, *Lecanium armeniacum* Craw.

Craw, Alexander	Cal. State Bo. Hort. 1889, p. 198.
	Cal. State Bd. Hort. 1891, p. 197.
Webster, F. M.,	Can. Ent. Vol. xxx, 1898, p. 81.
Britton, W. E.,	'Ann. Rep. Conn. Exp. Sta. 1898, p. 273.
	Ann. Rep. Conn. Exp. Sta. 1899, p. 242.
Felt, E. P.,	U. S. Dept. of Agr., Div. of Ent. Bul. 17 n. s. 1898, p. 22.

---

* Kindly determined for me by Dr. L. O. Howard, of the Department of Agriculture, Washington, D. C.

† Cornell University Experiment Station Bulletin 97, 1895.

The New York Plum Scale, *Lecanium cerasifex* Fitch.

Slingerland, M. V.,	Cornell Agr. Exp. Sta. Bul. 83, 1894.
Howard, L. O.,	Year-book U. S. Dept. of Agr. 1894, p. 272.
Smith, J. B.,	Ann. Rep. N. J. Agr. Exp. Sta. 1894, pp. 500-501.
Lowe, V. H.,	Ann. Rep. N. Y. State Exp. Sta. (Geneva) 1894, p. 732.
Cockerell, T. D. A.,	Can. Ent. Vol. xxvii, p. 60, 1895.
Lowe, V. H.,	Ann. Rep. N. Y. State Exp. Sta. (Geneva) No. 14, 1895, pp. 574-593.
	N. Y. State Exp. Sta. Bul. 136, p. 583-6, 1897.
	MSS. Thesis for degree of M. S. in Michigan Agr. College.

THE PEACH LECANIUM.

(*Lecanium nigrofasciatum* Pergande.)

A scale that for many years has been known in the states south of us is the peach-scale or peach Lecanium, long thought to be identical with the peach-scale (*Lecanium persicæ*) of Europe, but separated from that species and described by Mr. Theo. Pergande of our National Department of Agriculture.* So commonly has this pest been found on peach, that it is known as *the* peach scale although it is by no means confined to the peach as a host-plant, being found also on cultivated plum, native plum, *Prunus simonii*, sugar maple, *Acer pseudoplatanus, Acer rubrum drummondii, Cratægus* (thorn), sycamore, *Bromelia, Lindera benzoin*, Olive and *Vaccinium*. It was found on soft maple in Michigan and probably on some other host-plants. While it has not, as yet, been sent to us on peach or on any fruit trees, it is likely to be found on fruit trees at any time. In appearance this scale is somewhat different from the apricot scale and most of the fruit scales of this State, being small for a *Lecanium* and quite uniform in size and form. Specimens were received from Indiana on March 22, 1901, in perfect condition for study.

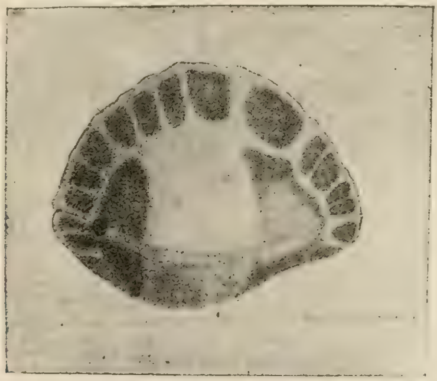


Fig. 5.—Peach Lecanium. *L. nigrofasciatum*. Adult female greatly enlarged. Original.

The scales are reddish-brown, elevated oval or pyriform. The elevation being nearly half the breadth. The top of the scale is lighter in color than the sides. See Fig. 5. There are about twelve radiating lines extending to the outer edge on each side, the spaces between being darker. The front and rear parts of back are also darker. The surface is shiny, smooth, and covered with a delicate thin coat of wax. Length three-sixteenths of an inch or a little more (2½-2¾ mm.), width about one-sixteenth of an inch (1½-1¾ mm.). They pass the winter nearly full grown.

---

* Bulletin 18, new series, Division of Entomology, Department of Agriculture.

In her excellent account of the life-history of this scale, Miss Murtfeldt speaks of the color as bright sealing-wax red with brown and black, at the time when just acquiring full size. The color disappears as the scale dries with age.

Microscopic mounts show the margin to be lined with a few spines, few and far between, with a set of three larger ones, on or near the lateral margin of the thorax and another set of three on each side opposite the antennæ. The middle spine in each of these sets is curved and much the largest, as is customary. There is a broken irregular row of glandular spots running from the anal plates forward two-thirds of the distance to the front margin. The anal plates are brown, surrounded by a narrow quadrate ring of brown. Antennæ are six jointed. Joint six equals four and five; three equals four plus five plus six; joint three equals one plus two and one equals three-fifths of two. There are a few hairs about the anal plates.

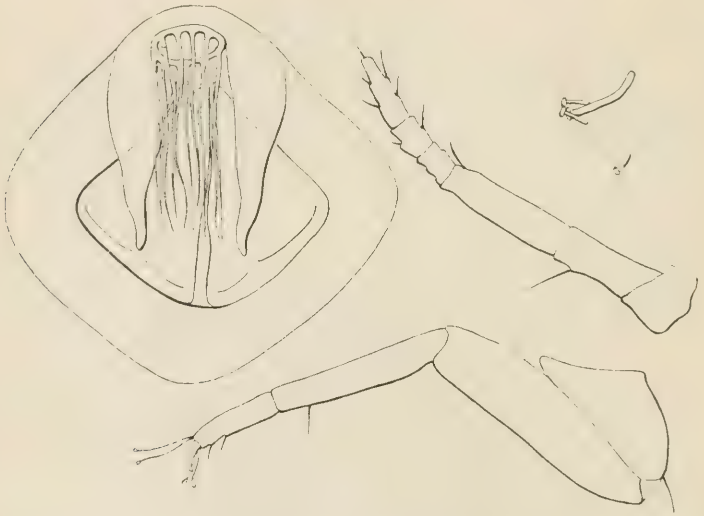


Fig. 6.—Peach Lecanium. *L. nigrofasciatum.* Anal plates, antenna, front leg, and group of three spines on lateral margin. Greatly enlarged. Original.

The effects produced by this scale are frequently serious to judge by a sentence in the account written by Dr. L. O. Howard.[*] He says: "It clusters upon the twigs and smaller limbs of peach trees in such masses as completely to cover the bark, and frequently to cause the death of young trees."

REMEDIES.

The fact that this pest does not hibernate in the same condition as does the apricot scale, renders the treatment slightly different from that used against the latter insect. The winter is passed by the peach *Lecanium* in a nearly grown condition and being unprotected by a scale, it will probably succumb fairly well to the usual winter washes. The eggs hatch, however, in June and July and the best time for fighting them probably will be during the period shortly after they are hatched and while the young lice are tender. At this time, during June and early July, a spray, or better two or three of them at intervals of two weeks apart, of kerosene-emulsion, diluted ten times, should be very effective.

---

[*] U. S. Year-book, Department of Agriculture, p. 271.

THE LARGE PEACH LECANIUM.

(*Lecanium sp.*)

A Lecanium on peach, the name of which has, as yet, not been determined, was sent the writer on May 16th, from Michigan. It was also found by the writer in another part of the State later. In the middle of May, the large females were full grown but still soft and no eggs had as yet been deposited.

The females of this species are clear deep brown in color, polished, with a liberal covering of flocculent cottony material. They measure from one-fourth to five-sixteenths of an inch in length, when full grown, sometimes a little more; from three-sixteenths to seven-thirty-seconds in breadth; and about one-eighth of an inch in elevation. The highest elevation occurs about one-third the distance from the anterior margin, at which point the breadth is also the greatest, there being on each side a rounded swelling from which there is a gradual slope to the posterior margin, and a more abrupt slope to the anterior margin. The space beneath the anal scales and in the anal fissure is often filled with white cottony material such as is found later with the eggs. The edges of the scale on the sides pass down to the supporting bark perpendicularly, flaring little or not at all. In front and behind the angle is necessarily more acute but even here there is little, if any, flare. The surface is smooth and polished, covered, except on the elevated swellings with a coat of pruinose material. The pink eggs are laid about the last of May.

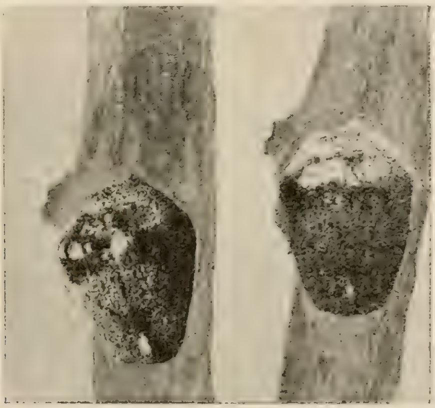


Fig. 7. Large Peach Lecanium. Adult females enlarged 4½ times from photograph. Original.

A microscopic examination shows the derm to be sprinkled with small more or less circular spots, each spot having a smaller round area, apparently on the surface of the derm. It is probable that these are the openings of the glands that produce the pruinose material. They are more numerous and larger in the anal region than elsewhere. The antennæ usually are six jointed, though sometimes they are seven jointed. There is a very great diversity of form in the different specimens at hand, those of a single individual often being quite different. There is, however, a type to which many of the individuals conform and which may be taken as the normal condition subject to great variation in different individuals. In the typical form the second joint is elongated, about as long as three, four and five taken together; joint one comes next, then six, and then three, four and five, which are sub-equal. Joint six varies considerably in length and sometimes joint three is elongated.

The orchard from which these scales came was not badly infested, but they were scattered about, a few in a place. No particular damage was sustained.

The hymenopterous parasite *Blastothrix longipennis*, was bred from specimens of this scale.*

---

* Kindly determined for me by Dr. L. O. Howard, of the Department of Agriculture, Washington, D. C.

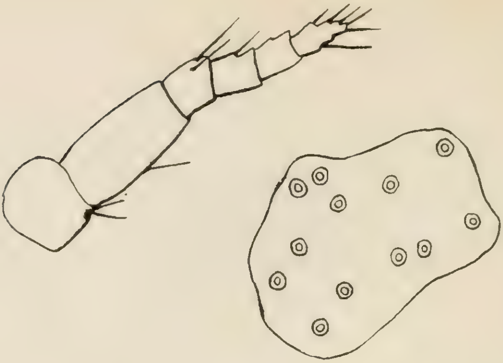


Fig. 8.—Large Peach Lecanium. Antenna and derm showing pores. Greatly enlarged. Original.

REMEDIES.

There is every reason to suppose that treatment similar to that used against the New York plum scale will be effective against this one. Winter sprays of kerosene emulsion being probably the best and cheapest.

THE ENGLISH-WALNUT SCALE ON PEACH AND MAPLE.

(*Aspidiotus juglans-regiæ Comst.*)

Examination of the large amount of scale-insect material collected and sent in during the past few years, has resulted in bringing to light another scale, closely related to the European fruit-scale (*Aspidiotus ostreaeformis*) and to the San Jose scale. It is the English-walnut scale, a pest unfortunately not confined to the walnut for food, but possessing a host-list covering quite a range of fruit and shade trees.

The first sample brought to light was on a peach tree, which was well incrusted with the scales and withal, having a sickly appearance. As this species was not at that time sufficiently familiar to the writer for certain identification, is was sent to Dr. Howard, Entomologist of the Department of Agriculture at Washington, D. C., and through his kindness Mr. Kotinsky examined the material and subsequently another lot on maple and mountain ash. Later this species was found on plum, doing serious injury. In appearance this scale resembles the European fruit-scale, especially when seen in numbers, although the writer never has seen them so numerous as the fruit-scales. The individual scales also resemble those of the fruit-scales. The female scales are rounded, brownish-grey in color, and flat, while the male scales are smaller, elongate and darker. When numerous, they often are covered with a sooty growth of fungus which subsists on the honey-dew secreted by the insects.

From an economic standpoint they are of first importance in Michigan, working as they do on peach and plum. Happily the infestations in the State, known to the writer do not number half a dozen, and these are partly on large shade trees, none of them being in nurseries.

The pest was first found by Professor J. H. Comstock at Los Angeles, in California, on the bark of English-walnut, in 1880 or earlier. Professor Comstock also found it on locust, pear and cherry. To this list may now be added black cherry, plum, Japan plum, apricot, sweet-gum, peach, soft maple, and mountain ash. The infestations in Michigan are confined thus far to peach, mountain ash, soft maple and plum. The English-walnut scale stands about on a par with the fruit-scale from an economic standpoint. The damage from its attacks has not as yet been as serious as that done by the

San Jose scale. The fact that it works on peach makes it especially unwelcome in our State.

The following description of the insect is taken from Professor Comstock's annual report of the Entomologist in the U. S. Year-book of the Department of Agriculture for 1880:

Scale of female.—The scale of the female is circular, flat, with the exuviæ laterad of the center; it is of a pale greyish-brown color; the exuviæ are covered with secretion; the position of the first skin is indicated by a prominence which is pink or reddish-brown. The ventral scale is a mere film which adheres to the bark. Diameter of scale 3 mm. (.13 inch).

Female.—The color of the female when fully grown is pale yellow with irregular orange-colored spots; oral setæ and last segment dark yellow. This segment presents the following characters: There are either four or five groups of *spinnerets*, the anterior group is wanting or consists of one to four spinnerets, the anterior laterals consist of from seven to sixteen, and the posterior laterals of from four to eight.

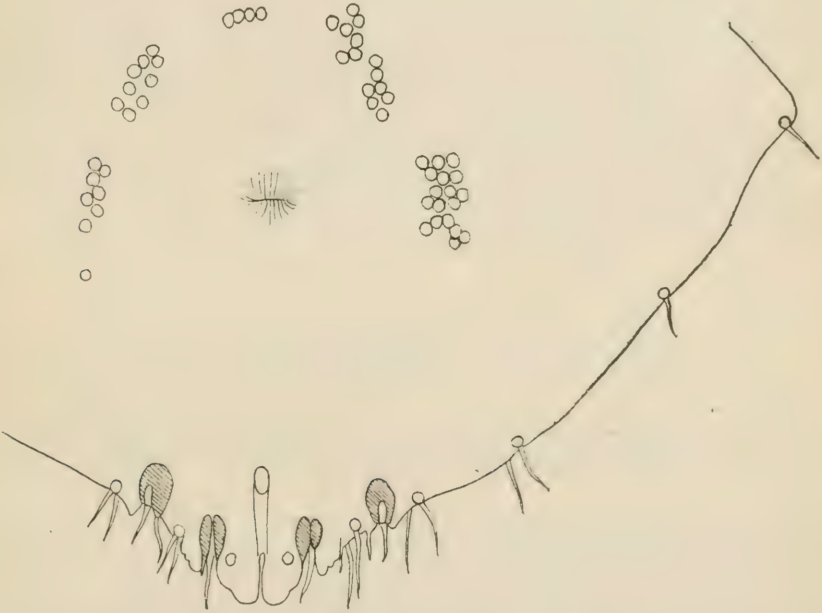


Fig. 9.—English-Walnut Scale. *Aspidiotus juglans-regiæ*. Last segment of female. Greatly enlarged. Original.

There are two or three pairs of *lobes*. The median lobes are well developed, but vary in outline; the second lobe of each side is less than one-half as large as the median lobes, elongated and with one or two notches on the lateral margin; the third lobe is still smaller and pointed or is obsolete.

There are two pairs of incisions of the margin, one between the first and second lobes of each side, and one between the second and third lobes; they are small but are rendered conspicuous by the thickenings of the body wall bounding them.

The *plates* are simple, inconspicuous, and resemble the spines in form. The larger ones are situated one caudad of each incision.

The spines are prominent, especially those laterad of the second and third lobes; the fourth spines are a little nearer the first lobes than the penultimate segment; and the fifth are near the penultimate segment; there is also a spine at or near the union of the last two segments.

Scale of male.—The scale of the male resembles that of the female in color; it is elongated, with the larval skin near the anterior end; this skin is covered by excretion, but its position is marked by a rose-colored prominence, as in the scale of the female; the anterior part of the scale is much more convex than the posterior prolongation, which is flattened. There is a rudimentary ventral scale in the form of two narrow longitudinal plates, one on each side of the lower surface of the scale. Length, 1.25 mm. (.05 inch).

REMEDIES.

The habits of this scale resembles those of the San Jose and European fruit-scale as well as the appearance and structure. All that has previously been said about remedies for the San Jose scale will apply equally well to this one. Winter spraying with whale oil soap or kerosene emulsion, or perhaps the kerosene and water mechanically mixed. In the mechanical mixture the oil should be used at the rate of one part of oil to five of water and the application should be made at first in a small way. See a few pages back on "Remedies" for "The Apricot scale on plums." If the emulsion is used, one part of the oil to six of water will prove sufficient. The whale oil soap will be required at the rate of two pounds of soap to a gallon of water, and the preparation should be applied hot. These strong sprays must be applied in the winter time, as they invariably damage or kill trees if used while the foliage is on. A weaker spray of emulsion or even the mechanical mixture has been successfully used in the summer time when it became necessary to check the growth of the scales at that time. Mr. Trine, State Inspector of Orchards and Nurseries, informs me that he has often found it expedient to check the San Jose and the fruit-scales with a mechanical mixture consisting of one part of oil to ten of water.

It must be borne in mind that these mechanical mixtures are made by a special pump, which takes oil from one tank and water from another, mixing them as they pass through and not by any arrangement that can be used with an ordinary pump.

CLOVER-ROOT MEALY-BUG ON SUGAR BEETS.

(*Dactylopius trifolii* Forbes.)

Early in June, several specimens or sugar beets infested with a white mealy-bug, were received from the Lansing Beet Sugar Co., having been sent in by the growers on suspicion. They were first noticed when weeding began, being numerous in some fields at that time.

The insects are minute, snowy-white fellows, very much like lice in appearance, but without wings and covered with a cottony secretion. They are generally so small as to escape notice unless present in numbers. When first received they were only partially grown. A little later, on June 28, a visit was made to the beet field of Mr. Schneeberger, near Lansing. The stand was considerably below the average at that time, the beets being very uneven in size throughout the field. On pulling up some of the smaller and weaker beets, the mealy-bugs were found in small numbers, not being nearly so plentiful as at the time of weeding, but by now fully grown and engaged in egg laying, the eggs being pale yellow and laid in a nidus of cottony material. Later, on July 23, it was not possible to find any of the insects although an examination of the field was made. This was probably due to the fact that the beets had grown to quite a size, increasing the area of feeding surface very greatly and making it difficult to search thoroughly.

The adult females collected on the 28th of June proved on examination to agree perfectly with the clover-root mealy-bug (*Dactylopius trifolii* Forbes),* and this opinion was confirmed on learning that the field was in clover the year previous. It was impossible to refer with certainty, any injury to the beets from this insect, although the smaller, stunted roots were invariably the ones infested; whether the insects helped to stunt the beets or whether the stunted beets proved more to the needs of the mealy-bug, is impossible to say. Quite likely the latter is the case since many coccidæ thrive much more vigorously on host-plants that for some reason are sickly. The beets in the field visited, later took a start and made a good growth, although the field continued to appear uneven.

---

* Fourteenth Rep. State Entomologist of Illinois, 1884, by S. A. Forbes.

The following description of the adult female is taken with a few corrections, from the writer's account of this insect on clover in the Canadian Entomologist of October, 1899:

The adult female measures a little more than two millimetres in length, is reddish-brown in color, covered with a coating of waxy or mealy secretion. The legs are dirty yellow in color. From the sides project from 15 to 17 (usually 17) waxy processes, forming a fringe around the body in the usual manner, with the shortest filaments near the head, and those near the tail considerably longer, sometimes one-third as long as the body. The antennæ are eight-jointed; joint one is swollen, as broad as long; two and three subequal, each about as long as one; four, five, six and seven subequal, a little over half as long as two or three; eight usually a little longer than five and six joined. There is considerable variation in four, it is sometimes smaller than five, six or seven, and sometimes slightly larger. The legs are dirty yellow, in length the tarsus of hind leg is slightly more than half the tibia, which about equals the femur. Digitules four; the two superior long and slender, the two inferior shorter and more stout. (The digitules were not distinct, but appeared as described.) Anal tubercles not prominent, with a mass of small glandular spots and bearing one long hair, with sometimes several smaller ones. Among the glandular spots are placed two conical projections or processes on each tubercle. These processes are from two to three times as long as broad at the base. Derm dotted with small round glandular spots. Back near the caudal margin, spotted with larger round glandular spots.

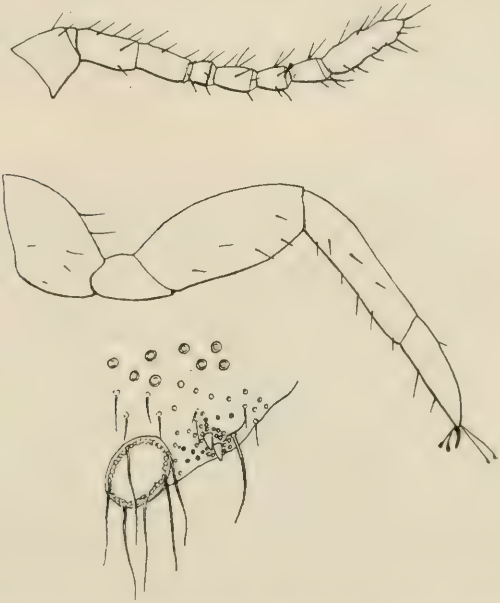


Fig. 10.—Clover-root Mealy-bug. *Dactylopious trifolii.* Antenna, leg and ano-genital ring. Greatly enlarged. Original.

THE GRAIN APHIS.

(*Siphonophora avenae* Fab.)

In 1889, a general outbreak of the grain-louse occurred in Michigan. In 1900 this was repeated, though on a smaller scale. Specimens of wheat infested with the lice were received from various places, and an examination of the college wheat fields showed a fair sprinkling of the pests. Fortunately the lice did not make their appearance until after the wheat was well headed nor did the attack last long. Fig. 11 gives an idea of the appearance of this louse. It is green in color with black markings. Both winged and wingless forms are present, the latter predominating. From the hinder part of the abdomen, there projects a pair of slender tubes, the cornicles, whose office it is in most other lice to secrete honey-due. The insect is known to work on many different hosts, such as wheat, rye, barley, oats, soft chess, orchard-grass, *Holcus* and *Poa*, Sorghum, canary-grass and others.

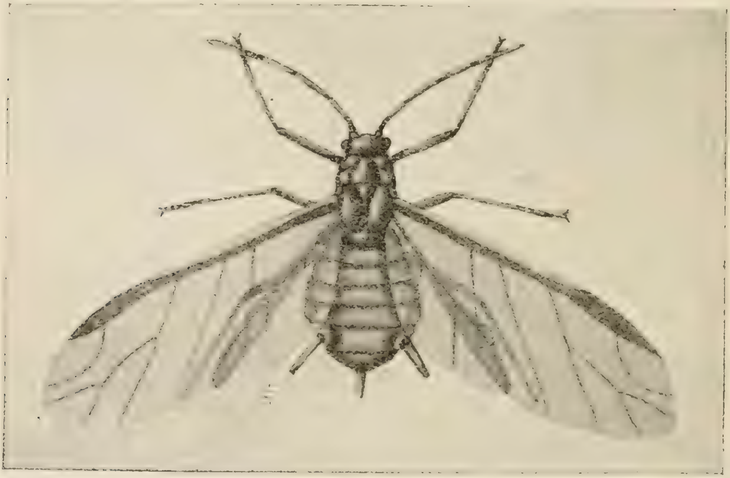


Fig. 11.—Grain Aphis. *Siphonophora avenæ.* Winged female greatly enlarged. Original.

On the 27th of June, 1900, the farm of Mr. W. F. Potter, of Williamston, was visited. At that time, the aphids were disappearing, but just previously they were very numerous on wheat, chess, and beardless barley. The greener and younger plants were most badly infested, the stronger ones escaping a part of the trouble. A large number of heads of grain were collected and placed in suitable cages in the laboratory. Next day a number of parasites were to be seen moving about the cage, contrasting strongly in their quick nervous movements with the slow stolid motions of the lice. Each succeeding day brought out a fresh crop of parasites for about a week and they continued to emerge from time to time even longer. These parasites (Fig. 12) are black and dirty yellow in color and smaller than the lice. They have four wings, and move very quickly, constantly running about as if in search of something, and in truth they are, for if one be closely watched and its movements followed the interesting process of egg laying is likely to be observed. Wandering around among the plant-lice, one of the females will approach a young louse, make a careful examination, no doubt to make sure that no other parasite has been before her, and then standing firmly and squarely before or at the side of the stolid and immovable louse, the parasite will bring her abdomen forward between her three pairs of legs and with the ovipositor at the end, pierce the side of the louse, quickly depositing an egg inside the body of the victim. The stop is a short one and the parasite quickly goes in search of another louse. Now follows a season that must be one of exquisite torture to the host animal, for the egg hatches, giving forth a grub which feeds on the living body of the louse, avoiding for a time all parts that are vital, but finally devouring everything. Toward the last a marked change takes place in the appearance of the louse. A gradual swelling of the entire body commences and this is continued until the louse becomes rotund and nearly spherical. See Fig. 12. The swelling is occasioned by the spinning of a cocoon inside the body of the louse, in which the grub is to change to the pupa, and finally to the adult, winged, wasp-like insect of minute proportions like its parent. When the adult is ready to emerge a round lid is cut in the skin of the louse, which has turned brown, or bronzy-brown by this time, and the parasite steps out eager to commence a search for more aphids. Now as each parasite lays a number of eggs, the multiplication and increase of these little benefactors is very rapid indeed, and when they once get a good start in a field of aphids, the doom of the lice is usually sealed. The species of parasite that is here described and which did such good work in Williamston, is known as *Aphidius granariaphis* Cook.* It is one-tenth inch in length.

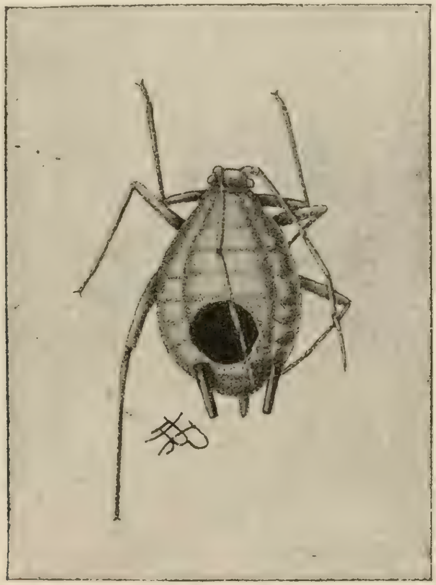


Fig. 12.—Grain Aphis. Parasitized by *Aphidius granariaphis*. Greatly enlarged. Original.

In the fields visited, the work of destruction went on very rapidly. In about ten days after the lice became alarmingly numerous, it was necessary to search in order to find good specimens and Mr. Potter tells me that the loss from the louse was not of serious consequence though it looked at one time as if nothing would be left. On several occasions severe losses have been caused by the grain louse, but in most cases the parasites have checked them before any serious loss has occurred.

Besides the *Aphidius* mentioned, many syrphus fly larvæ were seen feeding upon the lice and several adults were bred.

Experiments have been made in New Jersey, with kerosene emulsion as a remedial measure, but the feasibility of spraying a field of grain is at all times questionable, except in cases where the grain is very valuable. The emulsion will kill the lice, but under most conditions this method is impracticable. Another remedial measure is to apply a tonic in the form of one of the concentrated fertilizers. Nitrate of soda, muriate of potash, kainit, or some other like fertilizer to help tide the plants over the strain of supporting a number of plant lice.

---

* Canadian Entomologist, Vol. XXII, July, 1890, pp. 125-6.

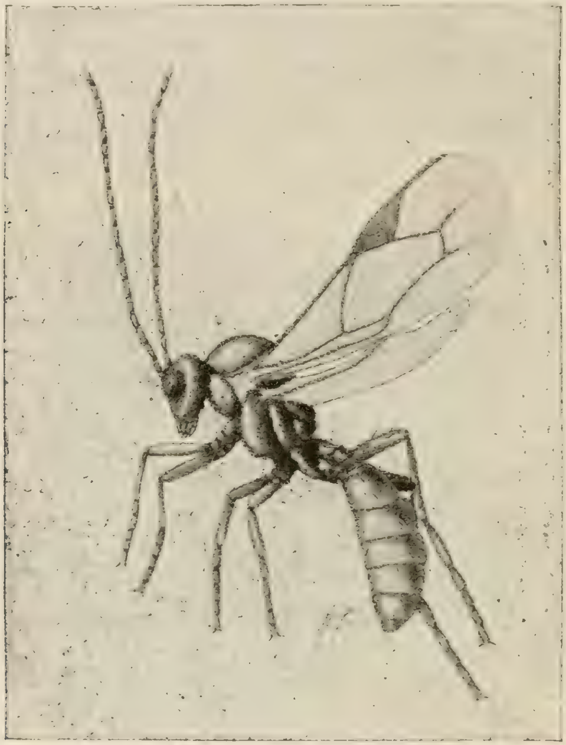


Fig. 13.—Parasite of Grain Aphis. *Aphidius granariaphis.* Greatly enlarged. Original.

Few better examples of the ups and downs of insect life could be obtained. The explanation in a general way, is very simple. During a favorable year, the lice multiply until they become very numerous, resulting in an outbreak. This continues for a time until the parasites, a few of which have managed to exist in isolated places, breed up sufficiently to overcome the lice. The parasites do not die out entirely although they often become so few that it takes them some time to multiply sufficiently to become effective, when food in the form of lice is provided. The parasites, after killing off most of the lice, die for want of food, only a few are able to find suitable lice to eat. For the parasites, it is a time of scarcity, they worry along in small numbers until suitable weather conditions as well as their own reduced numbers, allow the lice again to become plentiful. This constant warfare between the lice and their parasites results in constantly recurring waves of invasion. The distance between the waves usually being several years. This principle holds true with most insects, though in few cases is the destruction of the host so complete as in the case of the grain louse.

THE DESTRUCTIVE PEA-LOUSE.

(*Nectarophora pisi* Kalt.)

In May, 1899, an outbreak of this insect in the state of Maryland, attracted the attention of all interested in the industry of pea growing. Since that time, the trouble has spread to New York, Delaware, North Carolina, New Brunswick, Nova Scotia, Ontario, Ohio, and Wisconsin. Michigan has been the recipient of just enough damage to make it seem advisable to sound this warning note. In Maryland, the loss in 1899, most of which was ascribed to this insect, was estimated at three million dollars, and the injury as a whole seems to be becoming more widespread, rather than otherwise, although the condition is becoming better in the parts originally invaded. Prof. Sanderson, in his admirable account of this pest, considers it identical with the European pea-louse, which has been known and dreaded for many years, and which is called the "green dolphin."* The appearance of the destructive pea-louse closely conforms to that of most plant-lice. It is a large-sized green louse either winged or wingless, the latter form predominating. It feeds upon clover and vetches, besides peas and is said to feed also upon various other plants. It is said to pass the winter on clover, greatly preferring crimson clover to all others.

Michigan has, thus far, escaped with comparatively slight losses, but the pest is in Ontario, Ohio and Wisconsin, and has already done some damage here. We can hardly hope to escape scot-free. The insect has been found here at Saginaw, Cheboygan, Sault Ste. Marie, Gladstone, Petoskey, Harbor Springs, Alpena, Ludington, Charlevoix and Lansing.

Specimens collected in the vicinity of Traverse Bay by the writer were identified as the green pea-louse, but in order to be certain it was thought best to send them to Prof. Sanderson, who kindly compared them with material from other localities and pronounced them identical. The damage in all these places was slight. At Harbor Springs, most of the damage was done to sweet peas in 1900. At Ludington, the damage seems to have been restricted to a small area, and at Charlevoix, only one field was at all seriously injured. The rest of the localities named had merely a small infestation except Alpena, the details of which infestation I do not know.

In reply to a letter Messrs. D. M. Ferry & Co., of Detroit, write the following in part: "We would say that we have grown peas in Michigan for the past twenty years or more and there have been few years when one or more of our crops have not been injured to a greater or less degree by lice which we thought were the common 'green fly' so often seen in green-houses. At the same time, the pest has never been so serious a one as to materially affect the average yield, and we have thought that the natural enemies of the insect, such as the common 'lady-bugs' and unfavorable weather conditions (for the lice) could be depended upon to keep them in check. The past year we saw one crop which was badly infested and the plants practically destroyed in part of the field. At that time there were a great many lady-bugs at work and when we visited the field some weeks later, the lice had disappeared and we harvested a fair crop on all but a small part of the field where the lice were the worst."

The above letter shows that the pea-louse is not a new insect in our State and that, at least up to the end of 1900, it had not become serious. It is, however, coming nearer and nearer, gradually closing in on us and in a State like Michigan, where clover is so freely grown, I repeat, we cannot hope to entirely escape.

It seems best therefore, under the circumstances, to make known the best methods of combatting the pest in order to anticipate. It is hoped that any outbreak of this or in fact any other insect, will be immediately reported to the entomologist in order to make it possible to carry on experiments on our own account and in our own State. It often happens that a measure which may prove perfectly satisfactory in one district is of comparatively little use in another. In order to get the best results it is necessary to compare the different methods in our own State under existing conditions of weather and soil taking into account cost of insecticides, cost of labor, price obtained for the product, etc.

---

* Twelfth Annual Report Delaware College, Agricultural Experiment Station for 1900, p. 175.

REMEDIES.

The methods of combatting this insect in other states are two in number—first, the brush and cultivator method, recommended by Prof. W. G. Johnson, formerly State Entomologist of Maryland. When this is used the peas are sown in rows from 24 to 30 inches apart, instead of in drills as is ordinarily done. When the peas become infested and at intervals as required, the lice are brushed in between the rows from the vines and covered by a cultivator before they can get back on the vines. In order to do this, two boys walk in the open spaces between the rows, leaving one space between them, into this middle space they brush the lice with brooms made of fresh-cut pine branches. Just behind them in the middle space follows the cultivator, which buries the lice. If a hot day be selected a large proportion of the lice will be killed.

The other method is that of spraying. Prof. Sanderson, of the Delaware Station, describes* in detail the apparatus used by Messrs. Brakeley, of Bordentown, N. J. The machine described sprays four rows at once, and has a device for lifting the vines and spraying from underneath as well as from above. Whale oil soap is the killing agent used. It is dissolved in water at the rate of one pound of soap to six gallons of water. In hogshead lots, whale oil soap can be obtained for three to five cents per pound, making the mixture cost less than one cent a gallon. Kerosene and water was tried by Prof. Sanderson at the rate of 15%, but the kerosene evaporated too quickly to be effective. A 25% mixture was more successful but was not tried on a large scale. However the soap is much cheaper if used in quantity and furthermore the soap can be applied with an ordinary pump and bordeaux nozzle, while the kerosene and water require an expensive pump to do the mixing.

Experience has shown that this louse works worse on late peas than on early ones. In some places it has been found profitable to select early varieties for growing so far as possible. While the method of growing peas in rows is apt to cut down the yield in bushels, it allows of cultivation, which has many advantages when quality is an object.

Another item that must not be overlooked is the benefit derived from careful fertilizing. It is a general principle that a crop will withstand attacks by insects much better if in a vigorous, healthy condition. The sap does not seem to agree nearly so well with the insect constitution when the plant is strong as it does under other conditions. Especially is this true with plant-lice and scale-insects. Therefore fertilize well, cultivate well and be prepared to fight on the first appearance of the lice.

THE CANKER-WORM.

(*Anisopteryx pometaria* and *Paleacreta vernata.*)

These insects have been so recently discussed in a bulletin of this station, and are so well-known that is seems unnecessary to go into details in regard to the life-history, etc. There exists a strange apathy among the farmers, which must be dispelled before very much can be done toward overcoming this really serious menace to the apple interest of the State. The ravages of the canker-worms continue to increase from year to year and many owners of fine orchards look on and expect the trouble to cease of its own accord or else they try some sort of a spray, fail and lose heart. Meanwhile the canker-worm does not stop as a rule but becomes worse from year to year. The canker-worm works on many shade trees beside fruit trees and in this way it is tided over from one season to another.

There seems to have been great difficulty in fighting this pest in certain parts of Michigan. One orchard visited in the eastern part of the State, has been infested for many years. The owner had sprayed it for over ten years, and then became discouraged. He had used poison stronger than was necessary and had put it on with a lavish hand but the canker-worm refused to submit. An examination of the apparatus used showed the failure to be due to one weak point; the nozzle was not suitable for the purpose. It was coarse and would throw a semi-solid stream for quite a distance, but was not capable of throwing a *fine* spray at all. It was used in preference because it would carry well and did not require a long pole to get up into the tree. It threw drops of water laden with the poison and these drops would run down the leaves and drip off. The poison being heavier than water, would settle to the bottom of each drop and be the first to drip off the foliage. Now this is all wrong. As much depends on the way a spray is put on as on the material used. The spray should be fine, fog-like and should not carry very far anyway. A spray that will carry any distance will not be fine enough for good work. To get the spray up into the tree, use a long pole and have at least two nozzles at the tip. The writer has found the Vermorel to be a very suitable nozzle if the caps with the fine holes are used. Wet the tree from all sides and from underneath as well as possible, but stop just short of the point where it commences to drip. Do this as soon as the worms appear, if the tree is not in bloom, and in that case wait until the blossoms fall, but no longer. Use Paris green at the rate of one pound to 175 gallons of water with one or two pounds of good quick-lime (well burned stone lime). If the result is not satisfactory it will be very strange.

---

* Rural New Yorker, July 13, 1901.

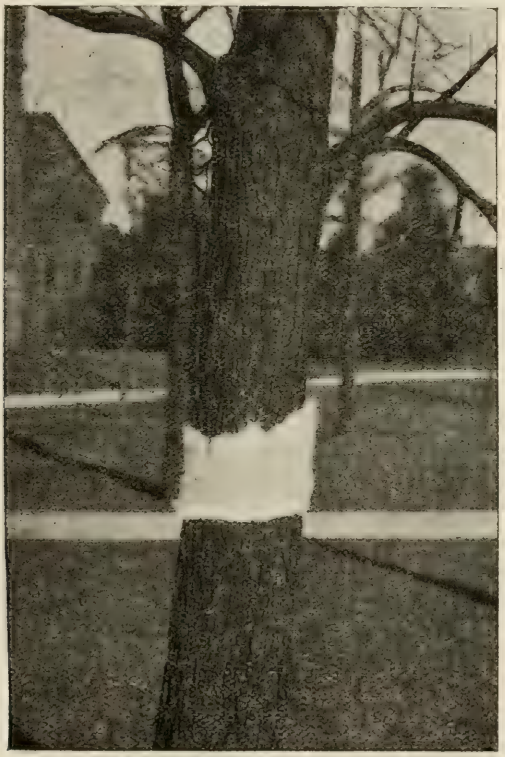


Fig. 14.—Banding a tree for canker-worm. First operation.

The writer has found the following method of preparing the poison very satisfactory in large sized orchards: Put from one-quarter to one-half pound of good quick-lime, or unslaked lime, in each of three or four tin pails which will hold about three quarts or less. Old cans or crocks will answer just as well. Add enough hot water to make it into a thin cream or paste. Now add to each lot one-quarter pound of Paris green, previously weighed out, and placed in paper bags, stir well while the lime is hot and let stand for a short time. Now measure out about 44 gallons of water into your spraying barrel and make a mark that will show you how high it comes in the barrel, and add the contents of one tin pail (viz. one-quarter pound Paris green and one-half pound quick lime slaked) into the 44 gallons of water in the barrel. Stir well and spray. The remainder of the tin pails or crocks can be used one at a time and refilled occasionally so that a stock is always on hand ready for use.

The poison prepared in this way has many advantages over that mixed directly into the barrel. Much of the Paris green that we buy is slightly caustic from the presence of free arsenious acid. The lime neutralizes the free acid and greatly reduces the danger of "burning" the foliage. It also serves to show where the work has been done and what is more to the point, where certain spots have been overlooked. It also helps to make the poison cling to the foliage, and greatly facilitiates the mixing of the poison into the water in the barrel, overcoming the tendency to collect on top of the water in bubbles and scum.

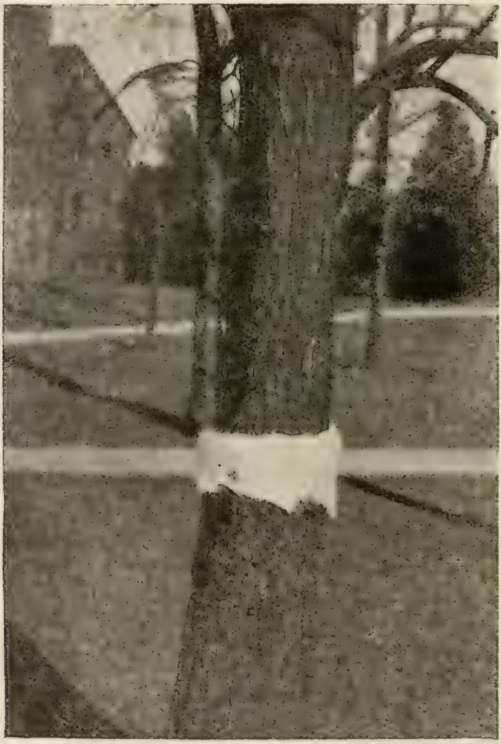


Fig. 15.—Banding a tree for canker-worm. Second operation.

So many complaints that spraying is not effective have come to us that a trial was made on May 25th, and 27th, again to test the spray. President Snyder kindly offered the use of his orchard for the test. The orchard had just been purchased and had been well supplied with canker-worms in 1900. The weather was anything but suitable for the purpose, being rainy during the latter part of May and the first part of June.

On the 25th and 27th of May, most of the trees were sprayed with Paris green according to the directions given above. The worms were present in force. It rained on the 25th and stopped the work. On June 3d the work was repeated, all the trees being sprayed, Mr. E. R. Bennett doing the actual spraying in each case. A slight "burning" of the foliage of a few trees was noticed, owing to the wet conditions during the work, and the fact that in one case, the barrel had been refilled before it was empty, resulting in a stronger mixture than was intended. The damage was not in any way serious and could not be seen after a little time. At the time of the second spraying the worms were greatly reduced in numbers. On June 10th, a visit was made to the orchard, and not a live worm was found. Dead ones were seen, their remains clinging to the foliage, but no sign of a live one. The dates here given may seem a little late and often the trouble commences earlier, but it must be remembered that the spring of 1901 was late in regard to fruit of all kinds in central Michigan.

It often becomes necessary to spray twice in succession and sometimes three times, as certain parts of the tree are almost sure to be missed the first time and these are covered by the second or third, or the poison of the first application may be washed off by rains and need to be replaced.

Another remedial measure which is usually efficient is banding the tree with cotton batting, or printer's ink spread on a strip of paper. Figures 14 and 15 show how the band of cotton is applied. A loose band of the cotton is first placed around the tree (See Fig. 14), and a string tightly tied around the tree near its lower edge. The upper edge is then pulled down or turned over the lower tied part, just as a glove is turned inside out in taking it off. The female moths, having no wings, are obliged to crawl up the trunk of the tree in order to lay their eggs, early in the springtime just after the ground thaws out, and also late in the fall. The cotton band acts as an effectual barrier so long as it remains fluffy and soft, as the insects get entangled and perish there.

LIME-TREE INCH-WORM.

(*Hibernia tiliaria* Harr.)

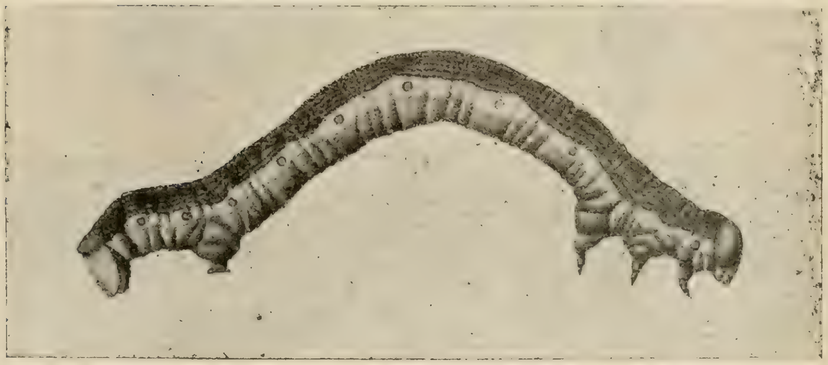


Fig. 16.—Lime-tree Inch-worm. *Hibernia tiliaria* enlarged. Original.

From time to time inquiries come in about yellow and brown striped measuring-worms either on apple or on shade trees. In the vicinity of the Agricultural College it is no uncommon thing to see apple trees with a moderate quota of these brightly colored loopers levying their tax on the tree with other insects, all of which taken together succeed in sensibly reducing its vitality. In the woods they are even more numerous. I have found them working on maple, beech, blue beech, basswood, box-elder, elm and apple; and they are said to work also on hickory and oak.

In appearance the larva is somewhat as follows: Being a "measuring-worm" it lacks legs except at the ends of the body. It progresses by means of the method known as looping, measuring off its own length each time it straightens out its body. The length is about 1⅛ inches. The head is light yellowish-brown with the labrum and lower part of the clypeus lighter yellow; legs dirty-white and pro-legs tinged with brown. The anal plate is yellowish-brown.

The back is dark brown with ten longitudinal black lines running the entire length from the anal shield to the prothoracic shield. These lines are fairly well defined except in the caudal region where they become somewhat interrupted and confused. This, in a lesser degree, is true in the thoracic region, where one or two extra lines are added on each side.

On each side is a broad egg-yellow stripe including the spiracles which are white with black borders. The underside is dirty-white.

The life-history of this insect is very much like that of the canker-worms. The female is wingless, like that of the canker-worm, and the male is winged, but larger than the moth of the canker-worm. It is buff-brown in color. The eggs are said to be laid in the fall, and the young emerge in May, here in Michigan. On May 22, 1891, the young were from one-quarter to one-half inch long. On June 11th the larvæ were nearly all full grown and many of them had gone into the ground.

The remedies to be used against this insect are the same as those for the canker-worm, viz.: banding the trees and spraying with the arsenites.

PHIGALIA STRIGATARIA.

Accompanying the lime-tree inch-worm and often feeding on the same trees, numbers of caterpillars have been seen for the past four years. They are dirty brownish-white with longitudinal black lines, and with spiracles black. On the intermediate abdominal segments and on the 11th are small, elevated, setose points. The head is dirty-white with black mottlings. The ventral part of the body is less distinctly lined. The feet are black. The length of a full-grown specimen is usually about one and three-sixteenth inches.

The caterpillars appear in May and last about five weeks. On the 22d of May, 1901, the young loopers were from one-quarter to one-half inch long. On the 22d of June all had gone into the ground to pupate, both in my cages and in the woods. There were found feeding on wild cherry, hard maple, beech, basswood, and blue beech. They are said also to feed upon apple, rose, blackberry, elm, and other plants.*

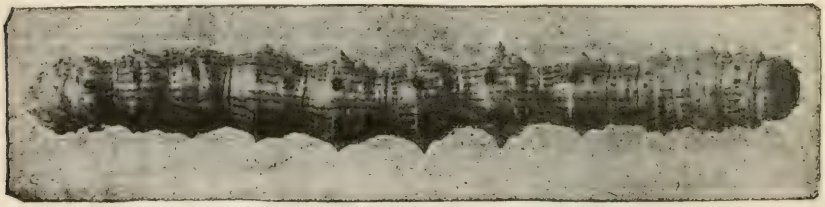


Fig. 17.—*Phigalia strigataria* larva or caterpillar. From photograph enlarged. Original.

On June 5, 1900, specimens of this larvæ were collected and placed in a suitable breeding cage. Early next spring a single adult winged moth appeared, which agrees with the description of *Phigalia strigataria*.† The adult males of this species are grey in color, with brownish-black lines running across the wings. They measure a little less than an inch and a half from tip to tip of the extended wings. The females are said to closely resemble those of the lime-tree inch-worm, being almost wingless, the wings being so short that they reach only to the rear end of the thorax. Being rudimentary, they are of no use for flight and the female is obliged to climb up the tree just as are the females of the canker-worms and lime-tree inch-worm. The males of this species are on the wing about the middle of April, being often attracted to the electric lights.

The methods of suppressing this insect will be the same as those recommended for the inch-worm and the canker-worm.

---

* Dr. Otto Lugger, Bulletin 61, Minnesota Experiment Station, 1898, p. 249.

† U. S. Geological Survey Terr. Vol. X, Monographs p. 407.

THE BARRED-WINGED ONION-MAGGOT.

(*Chætopsis ænea* Wied.)

In October, 1899, two onions were sent to the writer from Climax, Mich. These onions appeared to be infested with the common onion-maggot. The serious results that have since come from the species sent at that time induces us to give this preliminary notice with the intention of carrying on experiments, and later of giving a more detailed and full account, in the light of such future experiments.

The onions above mentioned contained a number of small white maggots about five-sixteenths of an inch in length. Two or three of them were preserved in spirits and the onions with the remainder of the larvæ were placed in a suitable cage in hopes of rearing the adults. In the spring the adults were obtained, besides several pupæ that did not succeed in transforming. These puparia were polished brown, about three-sixteenths of an inch long. The flies that emerged measured about three-sixteenths of an inch in length and with the wings laid back, about one-quarter inch from the front of the head to the tips of the wings. In color, the fly is metallic blue-green except the head, which is mostly hoary, with brownish-black eyes. The wings are transversely banded with three smoky bands, the outer two bands coalescing at each end. The fly was so different from anything known to work on onions, that it was sent to Dr. Howard, of the Department of Agriculture, through whose kindness it was identified as *Chætopsis ænea* by Mr. Coquillet.

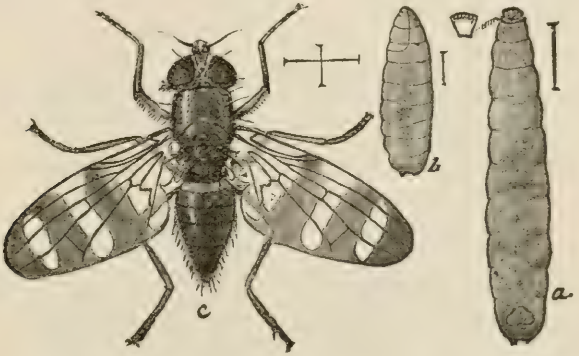


Fig. 18.—Barred-winged Onion-maggot. *Chætopsis ænea* from Riley and Howard Insect Life. U. S. Department of Agriculture.

Mr. Andress, from whom the original lot came, writes me that he composted 700 bushels of onions because of this insect, or what he supposed with good reason to be this insect. At least the samples sent me were taken from the same lot of injured bulbs. He wrote me later that his entire crop of 1900, amounting to 2,000 bushels, was destroyed, and that he had stopped raising onions for a time. Other onion raisers in that region have also had trouble with the pest.

So far as the writer knows, this is the first time that onions have been attacked by this insect, with the following possible exception: Prof. Slingerland, in his admirable work on the cabbage maggot and the onion maggot, Bulletin 78, page 556, of the Cornell University Experiment Station, says—"In his report for 1893, page 441, Prof. J. B. Smith mentions that some experiments were made on a fly larva which was at first mistaken for the onion maggot. He writes us that this Ortalid larva was remarkably resistant to almost anything that I could use, except kerosene." It is very possible that the trouble in New Jersey was due to this same pest, which seems not to have been identified at the time of the trouble.

In our cages the maggots passed the winter inside the onions.

Something of the past history of this erratic fly is told by Drs. Riley and Howard* from whose paper we find that it has been found working in wheat, oats, corn, and sugar cane, having been observed by a number of different entomologists and that it ranges from Canada to the West Indies.

The adult was obtained on corn in fairly good numbers at the Agricultural College on August 13, 1900, and specimens that are almost certainly the same, have been repeatedly seen by the writer on *Phragmites communis* near the college. There is little doubt that the insect is many brooded. The adults are to be seen at widely different seasons.

REMEDIES.

The fact that at least part of the insects pass the winter in the pupal form, inside the onion, gives us the key to one measure to be taken, viz.: *Destroy all injured onions in the fall.* All young or growing onions should be pulled up and destroyed as soon as they show signs of infestation; further than this, remedial measures must be determined by experiment. It is likely that the most successful of the remedial measures will be along the line of deterrents or agents that will hinder the adult flies from laying their eggs, or else something that will kill the eggs or young larvæ while very young, for after the larvæ go into the onion, it is likely that nothing more can be done.

Of this class of remedies there are three that seem to be likely to prove worth a careful trial. These are carbolic acid emulsion, kerosene and sand, and tobacco dust. All three of these remedies should be of most use when the plants are young and before the maggots have had an opportunity to burrow out of reach. If the first brood is overcome, it is likely that the later broods will be less numerous.

The tobacco dust is to be used as near the plants as possible, and preferably while they are young.

Kerosene and sand is simply sand wetted with kerosene, a large cupful of oil to a pailful of sand, and placed along the rows. It needs to be renewed every week or ten days.

The carbolic acid emulsion is highly recommended by Prof. Slingerland.† He advises using the following formula:

Hard soap one pound, or soft soap one quart.
Water (boiling) one gallon.
Crude carbolic acid one pint.

The soap is to be dissolved in the water and while it is still boiling hot the acid is added and the whole churned by forcing the stream from the nozzle into the kettle, just as is done in making kerosene emulsion. Dilute with thirty (30) times its bulk of water and apply along the rows every ten days after the onions come up until June. It may be necessary to continue the treatment longer, but it is hoped that the trouble will cease if the first broods are killed off. If any injury results from the use of this emulsion, dilute it still more. Use the *crude* carbolic acid in making the emulsion as it is very much cheaper and just as good. Send specimens to the entomologist just as soon as the insect appears.

Rotation of crops should be practiced on general principles.

THE PLUM GOUGER.

(*Coccotorus prunicida* Walsh.)

Plum growers will not be pleased to learn that the plum gouger, a relative of the curculio, has finally been found in our State. The gouger works in some respects like the curculio, and is controlled by the same methods with modifications. The insect is shown four and a half times enlarged in Fig. 19. In appearance the adult beetle is quite distinct from the curculio, being about one-quarter inch long, exclusive of the beak. It is mottled light and dark brown, with whitish hairs that give it a pruinose appearance. The pro-thorax is light brown as well as the beak. The wing-covers are evenly curved without the four humps that characterize the curculio.

---

* Insect Life, Vol. VII, pp. 252-4.

† Bulletin 78, Cornell Experiment Station, p. 530.

Specimens of injured plums were found on August 22, 1901, on the College campus by Prof. U. P. Hedrick of the College, who turned them over to the writer. A search under the infested trees soon revealed the characteristic work of the gouger and led to the finding of a number of the insects themselves.

Reference to this insect is made in the Annual Report of the Board of Agriculture for 1894, page 210, by the Horticultural Department. There is, however, no mention made of finding the insect, the short description being included merely to give completeness to the list of plum insects.

The finding of the insect in Michigan is not surprising though it confines its work chiefly to the Mississippi valley and the West. In its methods of working and in its life history, the gouger resembles somewhat the curculio. The insect passes the winter in the adult condition feeding, in the spring, on the opening flowers of the plum in a manner at once peculiar and ingenious. The part eaten is the ovule, or the part that would, if left uninjured, in time become the seed. This ovule is in the center of the basal part of the bloom and not easily reached direct, so the gouger cuts a hole in the side of the calyx, or the green cup at the base of the flower, and reaching in with its long beak, eats the coveted part. This of course causes the blow to fall which oftentimes leads to the detection of the malefactor. Later the gouger feeds on the young fruits, boring holes in them and also laying eggs in them. The method of egg laying is described in detail by Prof. Bruner.* The egg is laid in a cavity cut in the flesh of the plum with no concentric flap as in the case of the curculio. The young grub hatches out and goes into the soft pit working therein, and developing while the pit hardens, leaving no sign of its presence inside the pit and very little outside the plum except perhaps a scar and sometimes a resulting malformation or gumming of the fruit. Here in the pit, the pupal stage is passed and during the latter part of August the adult emerges. It is a strange fact that the presence of this insect, large as compared with the size of the plum, seems to interfere so little with the development and ripening of the fruit, which takes place at about the usual time, sometimes being slightly accelerated. Infested fruit sometimes appears tempting, though often gummed; it usually does not fall until just before the exit of its inhabitant.

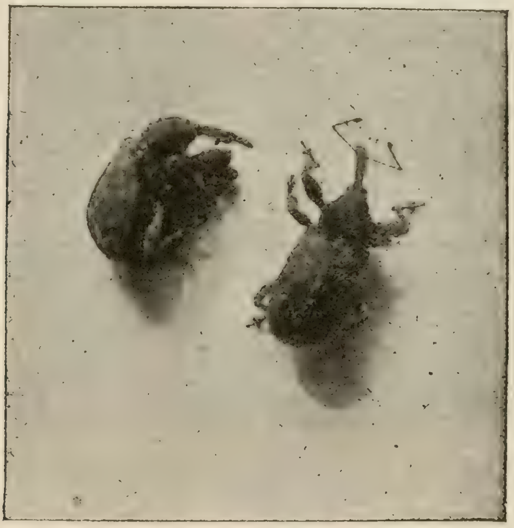


Fig. 10.—Plum Gouger. *Coccotorus prunicida.* From photograph enlarged 4½ times. Original.

---

* Insect Life, Vol. I, p. 89.

REMEDIES.

During the time of flowering and for a period before and after the same it is possible to obtain numbers of these beetles in an infested plum orchard by jarring. The writer has obtained them in numbers in Minnesota by simply holding an inverted umbrella under the small trees and jarring the trunk and large limbs with a padded mallet. It is far better, however, to place sheets on the ground under the tree and so to get almost all of them, or else to use a regular curculio catcher which is the same thing on a frame or on wheels. Gougers captured in this way count more toward obtaining good results than those obtained later, as the females still contain the eggs which are not laid until sometime afterward in the young fruit. This method should be followed up as long as results are forthcoming. The trees should not be shaken, but jarred, and well jarred, as the beetles cling harder than do the curculios. A mallet heavily padded so that it may be used to strike a sharp blow without injuring the bark, will be found useful for the purpose.

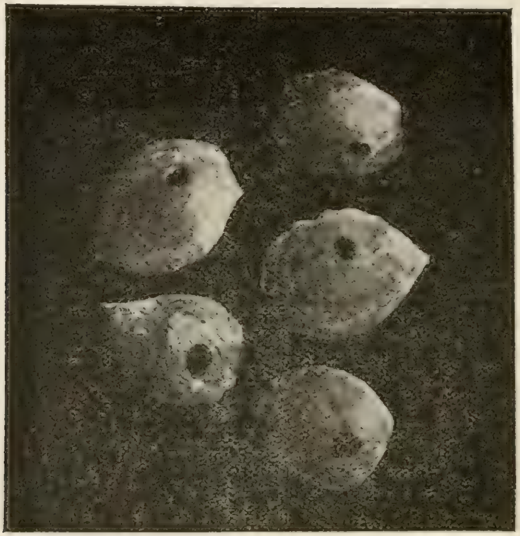


Fig. 20.—Plum pits perforated by Plum Gougers in making their exits. Slightly enlarged. Original.

Destruction of fallen and infested fruit.—The fact that most of the fruit falls just before the beetles emerge and escape gives us the clue to another measure, viz.: the destruction of the fallen fruit. This may be accomplished in several ways; either by daily picking up the fruit, of by turning in hogs about the trees. Where hogs seem objectionable, pick up and bury the plums, covering them well so that none of the beetles shall escape.

Professor C. P. Gillette,* who had experimented with this species at length, does not recommend the use of arsenites, having obtained little benefit therefrom. He does, however recommend a course which would be very effective if conscientiously carried out. He recommends gathering and destroying all gouged fruit, both on the tree and on the ground, between July 1st and August 10th. Such a course would require a great deal of labor, but if carried on over a good amount of territory it would be very effective, combining the benefits of thinning with those resulting from the destruction of the insects. Possibly the dates should be made a little later up here in the North, but not more than a week at most. Professor Gillette also points out the fact that the gougers greatly prefer the native varieties to the domesticated ones.

---

* Bulletin 9, Iowa Experiment Station, p. 388.

The writer has never had an opportunity to personally test a spray on these gougers, but it would seem that benefits ought to be derived from several good sprayings with Paris green and lime used at the rate of one pound of Paris green and one pound of lime to 175 gallons of water. See page 249.

THE OLD-FASHIONED POTATO-BEETLE.

(*Epicauta vittata* Fabr.)

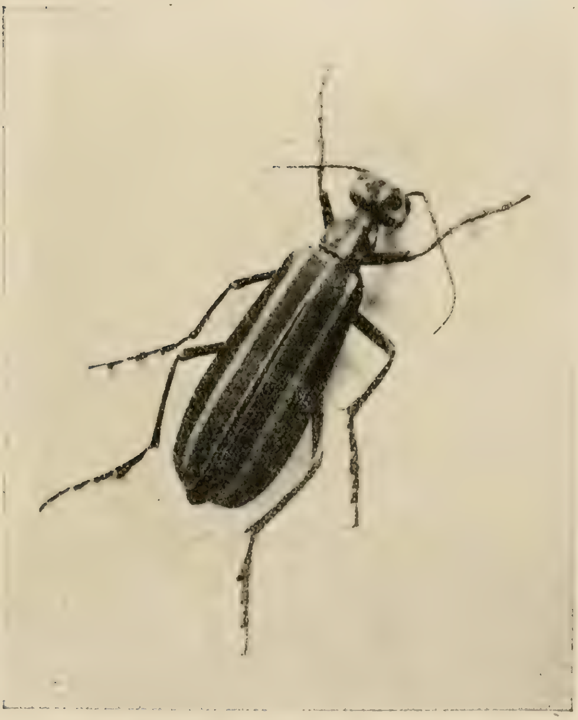


Fig. 21.—Old-fashioned Potato-beetle. *Epicauta vittata* enlarged 4½ times. Original.

Many of us will remember that before the advent of the common Colorado potato-beetle, there was a long, yellow and black beetle a little more than half an inch long that used to work on the potatoes. Since the coming of the Colorado beetle, the common one now, this old-fashioned fellow has retired from business, at least his presence has seldom been noticed in Michigan. The past year has witnessed a recurrence of these insects in numbers in parts of the State. They live on potatoes, tomatoes, sugar beets, and most garden truck. The beetle is a little over half an inch long with a reddish-yellow head, having two black spots on the back. The pro-thorax is black with three yellow longitudinal stripes or remnants of stripes, and each wing-cover is yellow with two black stripes running the entire length. The legs and antennæ are black and pubescent. See Fig. 21. It is also known as the striped blister-beetle.

The beetle in its immature stages feeds on grasshopper eggs as does the margined blister-beetle discussed in Bulletin 180, p. 132, of this office, and for this reason it is beneficial. It often becomes so numerous however, that it must be made away with in order to save our crops, in which case it can usually be killed by a spray of Paris green applied in the ordinary way, provided the insect is not too abundant. Paris green acts slowly on it and the damage may be all done before the poison takes effect. When they come in droves, it may be necessary to use other measures. It is said that they easily drive when brushed with branches from a tree, and that they may be driven from a field in this manner or driven into straw placed on the edge of a field and there burned. It is also said that they dislike dust on their food-plants and that air-slaked lime dusted on the plants will drive them away. If air-slaked lime is to be used, it will be well to add one pound of Paris green to every one hundred pounds of lime and to dust this on through coarse sacking or burlaps, after thoroughly mixing the whole together.

This old-fashioned potato-beetle is regarded as a southern species, which seldom does much damage as far north as this, though occasionally it has been serious. In his annual report for 1894, Mr. G. C. Davis, formerly of this station, records an invasion.

AËRATION OF MILK.

Bulletin 201—Department of Bacteriology and Hygiene.

(A popular consideration of Special Bulletin 16.)

CHARLES E. MARSHALL.

So many values and advantages have been attributed to aëration by dairymen that it has been thought pertinent and important to make an exhaustive and scientific study of the subject, especially in its relation to the handling of milk. The full details of the experiments appear in Special Bulletin No. 16 of this Station. This may be obtained on application.

In this popular and brief resumé of some of the results obtained, I desire to emphasize those only which have a direct bearing upon the care of milk and which may be utilized to advantage.

Aëration does have an influence upon milk, an influence which may be measured, but its importance may not be so great as is sometimes assigned to the process. When milk leaves the udder of the cow, the gas which is predominant, carbonic acid gas, begins to pass from the milk and the gases of the air take its place. This is brought about by the natural diffusion and solubility of gases.

The fact that carbonic acid gas exists in such large percentage does not indicate that this gas has any detrimental effect upon the individual consuming the milk directly from the cow; this would not accord with known facts. As soon as the milk leaves the udder of the cow it comes in contact with germ life; it is this germ life which is controlled largely by the conditions of the milk: in it there are germs of many kinds, some of which flourish readily where there are traces of oxygen only, and others where there is an abundance of oxygen. These germs produce the various fermentations of milk, consequently it makes a difference in the character of the fermentation whether there is an abundant supply of oxygen or not. Bacteriologists have shown that when there are only traces of oxygen present in a fermenting substance as milk there is more likely to result from the fermentation toxic substances or products which are really detrimental to the body. As milk comes from the udder there is little oxygen and much carbon dioxide, but after the aërating process the oxygen materially increases and the carbonic acid gas decreases. (See bulletin.) It therefore follows that aëration favors those fermentations which produce no poisons because where there is a plentiful supply of oxygen, toxic substances are not formed.

As the milk passes from the teats of the cow to the pail it is exposed freely to the air. At first thought, one might conclude that there is a free interchange of gas during the milking process. This is partly true, the carbonic acid gas fortunately falls about twenty per cent in amount. However, the process of aëration is difficult after a certain reduction of carbon dioxide has taken place or a partial equilibrium of gases established; and if a more perfect aëration is to be secured it is necessary that the milk be brought intimately in contact with the air by creating the greatest possible surface for the longest possible exposure. The more perfectly the drop can be shattered or a film established the more satisfactory the aëration.

If agitation of milk therefore aids aëration and if during the few moments immediately after milking the inter-change of gases between the air and milk is greatest, it follows that where milking is in process the air must be pure, otherwise the foulness of the air will be incorporated in the milk. Milk absorbs gases. What must be the condition of the air of a stable in which all sorts of fermentations are going on and in which are odors of diverse kinds? These obnoxious substances are in the air and must pass into the milk with the air.

In addition to milking, frequently the milk is further agitated in the stable by passing it from pail to pail or even straining it and also sometimes aërating it. Such methods are rightly condemned and the reasons for such condemnation are conclusive. Milking, and the handling of milk, should be carried on in pure air. It is sometimes the practice of milk-producers to pour milk directly from the milking pail into a ten gallon can. From the foregoing this must be considered reprehensible, for filling the can excludes the oxygen, and, if the milk is not cooled, a temperature most suitable for the development of germ life is present—conditions in short which favor harmful fermentations. This is why there are recorded so many cases of poisoning as due to the, improper care of the milk, eliminating the factor filth, a common evil.

Many dairymen have studied the action of aëration upon butter and cheese-making but without any positive results favorable or unfavorable. The results in the light of our experiments can be explained by a failure to recognize a difference between perfectly aërated and unaërated milk. The milk employed by these experimenters will show no great increase in the oxygen supply between that which was considered aërated and that considered non-aërated. If a wide difference could be established there would probably result appreciable differences in the products mentioned due to the influence the oxygen would have upon the ripening of cream and cheese, and the keeping qualities of the butter and cheese. These suggestions are tentative and subject to experimental evidence.

It has been hinted that aëration has caused an increase in the quantities of butter and cheese. Perhaps oxidation has some influence upon the fat and casein but thus far I have been unable to demonstrate it. In my work I have obtained marked peptonizing action by germs within twenty-four hours under an exclusion of oxygen, but this is not common. There were two samples of milk which were under conditions which excluded oxygen: these clarified completely in twelve hours in the incubator, that is, all the casein dissolved; *usually*, moreover, the milk loppered from lactic acid fermentation. If there is any difference therefore in the quantities of cheese obtained it is due largely to proteolytic fermentation induced by bacteria which might be favored by the exclusion of oxygen.

Our experiments further show that the number of bacteria is not reduced by aëration as has sometimes been suggested, and that the germicidal action of milk is not effected.

It has long been known that animal odors and taints may be removed by aëration. Proper aëration will do it; however aëration and cooling must not be confounded in this matter. Cooling apparently removes odors and taints but such disappearances are due to the chilling of the milk under which condition the milk gives up the volatile substances with reluctance, doubtless owing to the reduced power of volatility of the substances themselves when cold. When such odors and taints are removed by aëration the removal is permanent unless they are generated by bacteria which continue to grow after aëration. Odors and taints may be due to any one of the following causes:—

1. Absorption of gases from the air by the milk.
2. Physiological processes of the cow.
3. Disease processes of the cow.
4. Bacterial growth in the milk.
5. Introduction of odoriferous substances into the milk.

Odors in the air emanate from fermentations, foods, etc.; aromatic food substances are likely to pass through the body and be secreted in the milk; a high temperature in an animal is likely to reveal itself in the milk; many taints arise from bacterial development in the milk; and frequently sufficient filth gets into the milk to give it a distinct flavor—all of these or any one of these causes may be the immediate producer of odor or taint.

How aëration should be conducted is a matter of considerable importance, consequently we have added a few suggestions:—

1. Aëration should be conducted at body temperature.
2. Aëration should be carried out over the most extensive surface possible and as slowly as possible.
3. Aëration should take place only in a pure atmosphere.
4. Aëration is best accomplished immediately after milking.
5. Aëration should precede cooling.
6. Aëration and cooling simultaneously conducted cannot yield the most satisfactory results.

THE AËRATION OF MILK.*

CHARLES E. MARSHALL.

Special Bulletin 16—Department of Bacteriology and Hygiene.

Although practical aëration of milk may be traced back to an indefinite past, where it is simply mentioned and recognized, there has never been any plausible explanation or demonstration of the results claimed for it. Moreover, its application has always been conspicuously limited until within very recent years, and so far as its value is concerned at the present time, nothing has been satisfactorily established regarding it, other than the belief that it eliminates animal odors and removes, to a certain extent, tainted conditions of milk resulting either from physiological metabolism due to ingestion of aromatic food substances or produced by the growth of saprophytic bacteria in milk after the milk has left the udder of the cow. Even these animal odors and taints have been more or less undefinable and immeasurable; only daily practices in dairy operations have indicated and established beyond a doubt that both of these are greatly lessened by proper aëration.

Many other beliefs have been associated with or attributed to the process of aëration, such as the production of more cheese and better cheese, the production of more butter and better butter, the more rapid rising of the cream, the more rapid churning of the cream, the better keeping qualities of the milk and butter—all of these advantages have been assigned to aëration over the non-aëration of milk.

I. REVIEW OF AËRATION OF MILK.

Studying from the standpoint of the dairyman, Willard (1), Arnold (2), Lewis (3), Cooke (4), Wing (5), Plumb (6), Dean (7), and the Danes (8) under Storch have contributed to our knowledge of its application as it is at present practiced, but all of their work fails to explain the process or to state what aëration is. They do not throw light on why aëration may answer any of the above questions named. An attempt is made to demonstrate whether butter made from aërated milk is better than butter made from non-aërated milk, whether more cheese has been made from milk that has been aërated than from milk that has not been aërated. By these methods, perhaps, some valuable points have been settled, and still the future may change the character of this work wholly, since it is true they have not answered the question, "What is aëration?" or more explicitly, "were they really working with aërated milk or non-aërated milk?"

It seems pertinent at the start, that before we can understand or explain aëration of milk it is necessary we understand what aëration is, and we know whether we are producing aërated milk or not. All the practical experiments executed have been with aëration and non-aëration as they are known to us from present methods alone. The difference between the two may not be so marked as suspected and for this reason fail in producing the most noticeable effects. The starting point, non-aëration, must be first established and from that our conclusions should, in a way, be drawn; that is, we must determine any change in the carbon dioxide and oxygen content, with a decrease in the former and an increase in the latter as a process whose final limitations are not known or influences realized.

It is regretted that the value of our present aërating methods cannot be stated more exactly at this time, rather than depend upon the virtually negative results obtained by the individuals named in their endeavor to secure some practical explanation through their practical experiments. We hope to make this our next task; for the present we must content ourselves with the references to be gained from the evidence at hand. The aërating methods now in vogue in dairy operations may or may not yield results. It is not necessary to say whether these methods are effectual or not; for our purpose their value cannot be determined until each method has been worked out with pains-taking care. As soon as there has been established a non-aërated milk and a satisfactory aërated milk, then we may hope to reach some definite conclusion in its application to the dairy. Before this is done, the one hope that can be held out is that some of the aërating methods now employed may be giving some advantages over the non-aërating methods besides those which are recognized in the removal of odors and taints in a slight degree.

---

* Thesis presented for the degreee of Doctor of Philosophy, University of Michigan.

(1.) Willard's Practical Dairy Husbandry, 1871, p. 183.

(2.) Loc. cit.

(3.) U. S. Agric. Report, 1874, p. 397.

(4.) Ver. Exp. Stat. Report, 1892, p. 123.

(5.) Cornell Exp. Stat., Bul. 39.

(6.) Purdue Exp. Stat., Bul. 44.

(7.) College Reports (Guelph, Ont.), 1898, 1899, 1900, 1901.

(8.) 48 de Beretning fra den Kgl. Veterinaer-og Landbokijskoles Laboratorium for Landkonomiske Farsog.

The work which follows has for its immediate aim the demonstration of what constitutes non-aëration and aëration and how it may influence the condition of the milk itself and the germ content of the milk. After getting into the work it has been found necessary to eliminate for the present several side-problems which bear directly upon aëration and confine ourselves to the main line planned at the start. It should be noted, therefore, that all the aspects are not to be satisfactorily considered in this article, but rather, that a path has been hewn out of an unknown forest of doubt and ignorance which we may follow with profit in the future and may eventually be led to the solution of the whole question.

II. REVIEW OF THE GAS-CONTENT OF MILK.

The first problem which confronts the experimenter is to obtain a knowledge of the gas-content of the milk before exposure to the air. Dr. Felix Hoppe (9), in 1859, made a study of the gases of milk from a goat.

His analyses are as follows:—

First Analysis.

Carbon dioxide	9	parts.
Oxygen	9.57	"
Nitrogen	8.43	"

This trial should be regarded in the nature of a preliminary test.

In securing the milk he drew it into a funnel contiguous to the end of the teat of the goat, and conducted the milk into a flask from which the air was expelled as the milk filled the flask. To this method of securing the milk, there is an objection because the milk had been exposed to the oxygen of the air, not only in its agitation while passing along the tube in contact with the air, but also in the surface contact with the oxygen in the air in the flask itself.

Second Analysis.

Carbon dioxide	55.15	per cent.
Oxygen	4.29	" "
Nitrogen	40.56	" "

He secured 12.08 volumes of gas from 402 volumes of milk measured at 0° and 1 M pressure.

With this analysis the same criticism can be made as with the first analysis. He used the funnel but improved the design of the flask. When these analyses are compared, therefore, with the analyses of the gases from the milk immediately after milking, it will be seen at once that he has reached practically the same results; consequently his analyses are no more than the analyses of gases from milk immediately after milking. Without reference to his method of securing the gas, which is also open to condemnation, it follows that this work may be disregarded and is no criterion to follow when considering the gas-content of milk as it comes from the udder of the cow.

Stechnow (10) adopted another method of securing the milk. Olive oil, the best obtainable, was used to cover the milk. He inserted the end of the teat into the oil, then milked, thus maintaining a layer of oil over the surface of the milk. This, doubt-

---

(9.) Arch. f. path. Anat. und Physiol. u. f. klinische Medicin, 1859, Bd. 17, 5. 417.
(10.) Zeit. f. rat. Medicin von Henle u. Pfeuffer, Bd. 10, S. 285, 1861.

less, had an influence in restraining the effect of the oxygen in the air by keeping the air away from the surface of the milk and also reducing the oxygen content which the milk as it passed in a stream from the teat of the cow to the receptacle necessarily acquired. An objection, however, should be offered to the use of oil for the exclusion of oxygen, because it is a well known fact that oil contains oxygen in the form of super-oxygenated compounds, and also probably as free oxygen. In securing the gases from the milk a mercury pump was used as seems to have been the general practice with Stechnow and those who followed him, to which little criticism can be offered as viewed from the results obtained.

His analyses are as follows:—

First Analysis.

Carbon dioxide	77.50 per cent.
Oxygen and nitrogen	22.50 " "

He obtained 7.29 c. cm. of gases from 100 c. cm. of milk and employed for his analysis 67.5 c. cm. of milk.

Second Analysis.

Carbon dioxide	81.06 per cent.
Oxygen	1.93 " "
Nitrogen	17.01 " "

He obtained 8.29 c. cm. of gases per 100 c. cm. of milk. He used 297.5 c. cm. of milk.

Third Analysis.

Carbon dioxide	75.11 per cent.
Oxygen	4.79 " "
Nitrogen	20.10 " "

Total gas is equal to 6.67 c. cm. per 100 c. cm. of milk. Amount of milk used 256.3 c. cm.

Pflüger (11), believing that Stechnow was open to error in his method of securing the milk from the udder by shielding it as he did from the air by means of oil, attempted to overcome it by another device for conducting the milk from the udder to the receptacle without exposure to the air at all. To do this he employed a piece of rubber, fitting over the teat and udder of the cow as a glove would fit upon the finger; and, by means of a narrow rubber tube and glass tube was able to lead the milk into a vessel of mercury and collect it over mercury. He first expelled the air from the tube by milking for a time, filling the tube with milk, and then placing the free end of the tube under the mercury in the container. This course may be open to criticism in that there would be some leakage about the surface of the teat over which the rubber was fitted, but the analyses of Pflüger indicate that he was not troubled very much by the possible exposure to the air from this source and that the milk secured by this method was practically free, if not wholly free, from air. Further than this, his results are as satisfactory as any of the results obtained when other methods are employed for securing the milk, and which, in our case, we believe, did not allow of any exposure to the air at all. This will be shown later.

Pflüger's analyses are as follows:—

First Analysis.

Carbon dioxide	90.45 per cent.
Oxygen	1.19 " "
Nitrogen	8.36 " "

Amount of milk used was 60.77 c. cm. Amount of gas obtained per 100 c. cm. was 8.47 c. cm. No trace of gas was obtained after one hour.

(11.) Pflüger's Arch. f. Physiol., Bd. II, S. 166-173, 1869.

Second Analysis.

Carbon dioxide	87.16	per cent.
Oxygen	1.06	" "
Nitrogen	11.78	" "

Amount of gas per 100 c. cm. of milk was 8.49 c. cm. Amount of milk used 77.319 c. cm.

The analyses of all of these men were made directly after milking, and did not extend over a time sufficient to warrant fermentation.

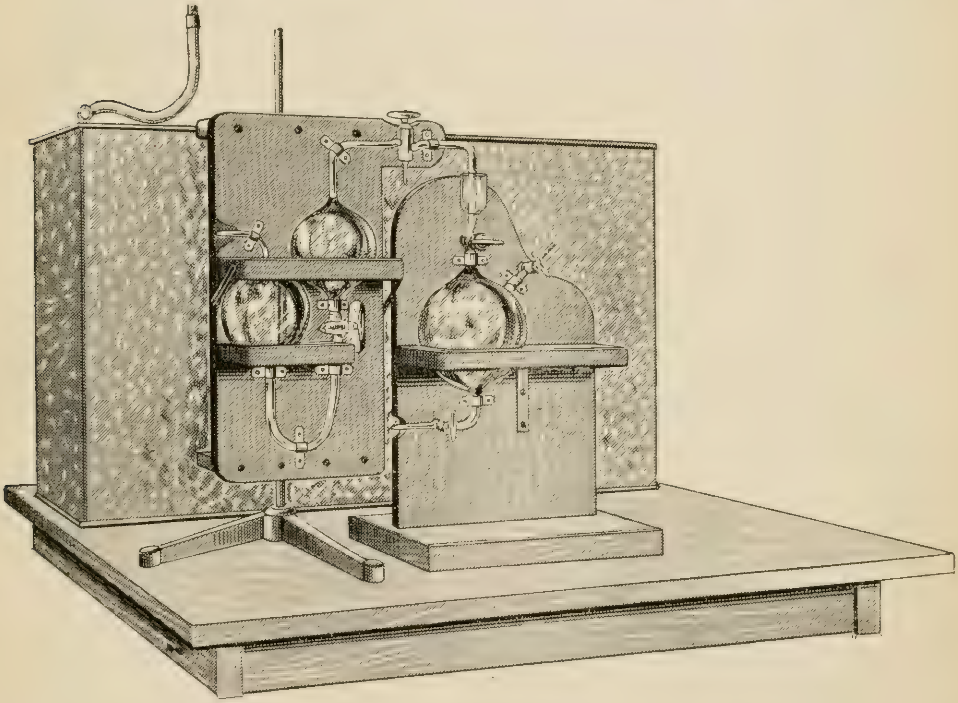
Pflüger was of the opinion that he had secured all the gas possible within one hour's time and made no allowance for a slow generation of gas after the hour when subjected to high pressure. This is not in accord with our experience, for after the first ebullition of gas which takes place early in the pumping process there follows a slight development of gas until fermentation sets in, when there is a marked increase.

III. DESCRIPTION OF APPARATUS.

For our experiments we departed from the methods used by Hoppe, Stechnow, and Pflüger, in that we endeavored to eliminate any possible chance of exposure of the milk to the air. Pflüger's method, the best previously adopted, is open somewhat to criticism in that there is a possible chance of the milk coming in contact with the air or being more or less churned with traces of air. His analyses, however, indicate that errors of this kind scarcely made any difference, in fact, he seems to have obtained about the same amounts of oxygen in his experiments as were obtained in ours. In order to secure the milk from the udder of the cow without any exposure to the air we employed a milking tube 6.6 cm. long attached and fitted to a piece of pressure tubing 80 cm. long and 5 mm. in diameter. The walls of this tube were 4 mm. thick. Over the aperture of the milking-tube was placed a piece of thick rubber tubing of small caliber so that it just fitted the tube. This served as a slide valve in closing and opening the apertures. The other end of the rubber tube was attached to a glass tube 5 mm. bore, containing a three way stop-cock and this in turn was attached to the receptacle used as a container for the milk by means of a short piece of pressure tubing. This will now be described.

The container for the milk is of the nature of a large bulb of heavy glass fixed securely to a standard of wood. It has three openings all of which are closed by means of a glass stop-cock at will. One of these openings is at the bottom of the bulb, another directly above at the top and the other a side arm on the right shoulder. The top arm consisted of a capillary tube containing a three way stop-cock an inch above the bulb, and above this a cup and a male portion of a mercury overlapping glass connection. The bottom opening and right shoulder opening were tubes 5 mm. in diameter, fitted with two way stop-cocks. When ready for use, this bulb, with a capacity of 562 c. cm., was filled with dry mercury. The side arm connected with the tube extending to the milk-duct of the udder was filled with mercury as far as the three way stop-cock; the remaining distance was filled completely with boiling water, driving out all the air, and when driven out, all of the apertures of the milking-tube were closed by means of a sliding rubber valve. When ready for drawing the milk, the tip of the milking-tube was carefully inserted into the milk-duct of the udder, and as the teat was pushed on the rubber valve over the apertures in the tube was pushed down, thus allowing the milking-tube to be inserted without the escape or the entrance of any air. When all was in readiness the three way stop-cock was so turned as to allow the water to run out and the milk to take its place; then the three way stop-cock was again so turned that the milk would run in the direction of the container. the stop-cock of the side arm of the container was also turned on. This made, therefore, a direct connection from the udder to the container of the milk without the presence of any air whatever. To draw the milk the stop-cock of the lower arm of the container was turned so as to allow the mercury to escape, drawing the milk from the udder as normally as it was possible. With the running out of the mercury the milk entered and filled all parts of the container, so that when the mercury had all escaped and the lower stop-cock turned off, the receptacle was completely filled without even traces of air.

As soon as the container was filled with milk direct from the udder it was taken to the laboratory and immediately connected, by means of the mercury valve of the top arm, to a modified Hempel pipette specially made for the purpose in which all rubber connections were excluded. The bulb of the pipette, the nearest the milk container when connected, was so made as to be above the second bulb, next to the Geissler pump. From the very top part of the bulb next to the container extended upright 5 cm. in length, a capillary tube; this then turned to a horizontal position for 10 cm.; finally turned downward in a vertical direction and connected with the mercury valve of the container, previously described, by means of its female portion. In the middle of the horizontal portion of this capillary connecting tube was another three way stop-cock which facilitated the filling of the tube with mercury. Therefore the container could be directly connected with the pipette through the capillary tube by means of the mercury connection. Before beginning to pump the gas off, the upper bulb of the pipette and the capillary arm were filled completely with dry mercury by means of the three way stop-cocks. This was done so effectually that no traces of air were present. A Geissler's pump was then attached to the upper stem of the lower bulb of the pipette, the air was removed, thus creating considerable pressure upon the mercury in the pipette. The stop-cock in the upper arm of the container was then turned so that the gas from the milk could escape and be drawn over into the upper bulb of the pipette and thus collected there. When the operation of pumping was completed the stop-cock in the upper arm of the container was again turned off. To this three way stop-cock was attached a Hempel burette, filled with mercury, by means of pressure tubing also filled with mercury. (It is understood that all rubber tubing connections throughout the entire experiment were further safeguarded by wiring.)



As soon as the pressure of the pump was released and reduced to normal conditions all of the gas was drawn over through the capillary tube and three way stop-cock into the burette where it was held for analysis. In carrying out the analyses of the gases we used Hempel's methods entirely, employing his pipette and White's (12) burette corrected for temperature and barometric pressure. The carbonic acid gas was absorbed

---

(12.) Jour. of the American Chemical Society, Vol. XXII. No. 6, 1900.

by means of potassium hydroxide, the oxygen was absorbed by means of alkaline pyrogallate and what remained was considered as residual gas. In the case of previous experimenters, the residual gas has been called nitrogen, to me a very presumptuous proceeding, inasmuch as there is apparently much concealed in the residual gas concerning which we know little. In the lower curves of the pipette a little mercury was placed to act as valves to prevent diffusion. The three way stop-cock of White's burette enabled us to fill the connecting tubes between the pipette and burette completely. By this means all errors were reduced to a minimum.

The milk used in these experiments came from one cow, and usually from a single quarter. In none of these analyses did the milk come from more than a single quarter, since a quarter contained sufficient milk to fill the container and the possibility of air entering in changing from one quarter to another was thus avoided. It was found in several cases, too, in our work that should the milk become exhausted in a single quarter the tissues closed over the apertures of the milking-tube and prevented the further flow of the mercury; this further demonstrates that no air could possibly enter by means of the apertures in the milking-tube. The whole apparatus including tubes, container, connections, and pipette was severely tested by several preliminary trials from the starting of the milk from the udder through to the securing of the gas from the milk by pumping. Everything had been verified by these preliminary trials. (In all of our gas analyses the barometric pressure has been reduced to 760 mm. at 0° C, unless otherwise stated.) (A uniform pressure during pumping was maintained by a large galvanized iron tank filled with water in which the entire apparatus was placed.)

IV. ANALYSES OF THE GAS-CONTENT OF MILK BEFORE EXPOSURE TO AIR.

The following six samples were run through and the gases analyzed with these results:—

TABLE I.

Sample.	I.	II.	III.	IV.	V.	VI.
Date	Dec. 9th.	Dec. 11th.	Dec. 13th.	Dec. 14th.	Dec. 16th.	Dec. 17th.
Began milking at	8:20 a. m.	8:05 a. m.	8:20 a. m.	8:20 a. m.	8:15 a. m.	9:00 a. m.
Finished milking at	8:35 a. m.	8:20 a. m.	8:35 a. m.	8:35 a. m.	8:30 a. m.	9:15 a. m.
Began pumping at	8:55 a. m.	8:40 a. m.	8:55 a. m.	9:00 a. m.	8:45 a. m.	9:40 a. m.
Completed pumping at	9:55 a. m.	9:40 a. m.	9:55 a. m.	10:00 a. m.	9:45 a. m.	10:40 a. m.
Temperature of water in tank	38°	38.5°	37.5°	37.5°	37.5°	37.5°
Barometric pressure in mm	688.63	695.265	682.937	686.93	694.937	690.937
Total gas obtained in c. cm	6 16	4.4	4.218	5.342	5.592	4.256
Free carbon dioxide in c. cm	4.96	3.44	3.447	4.3788	4.4825	3.667
Per cent. of carbon dioxide	80.58	78.35	81.73	81.97	80.16	86.19
Oxygen in c. cm	.117	.135	.1134	.1143	.0894	.09
Per cent. of oxygen	2.88	3.09	2.69	2.14	1.6	2.12
Residual gas in c. cm	1.02	.816	.658	.8489	1.02	.499
Per cent. of residual gas	16.54	18.56	18.27	15.89	18.24	11.71

The above six analyses furnish an average which is lower than that of Pflüger. but this does not appear to detract from the value of the work of either after considering the possible variation occurring in the gas-content of milk from the same quarter of the cow. The amount of carbon dioxide obtained in the above analyses is in percentages.

80.58, 78.35, 81.73, 81.97, 80.16 and 86.19.

The averages of these percentages is 81.49⅔ per cent.
Pflüger obtained in his anaylses 90.45 per cent and 87.16 per cent.
The average of Pflüger's analyses therefore would be 88.80 per cent.

Considering the extremes of the six analyses there exists a difference of 7.84 per cent. In Pflüger's the difference is 3.28 per cent. Between the two sets of averages, Pflüger's and ours, there is 7.30 per cent difference. Thus the possible variation in six analyses is greater than the difference between the averages of the two sets of analyses. The uniformity obtained in the six analyses also indicates that there can be no serious discrepancies in the analytical work, and it is difficult to say how much variation Pflüger might have had, had he made six analyses instead of two; furthermore, there is probably as much variation in the gas content of milk as there is in other constituents. This fact was brought out plainly in some of the preliminary tests which are not cited here because those tests served only to pave the way for these six analyses and to develop those points necessary for recording the systematic work. Pflüger further does not state the temperature at which the gas was pumped from the milk nor does he enter specifically into a discussion of the influences which might alter further the gas-content of milk.

He obtained a larger amount of gas from milk than we obtained. This alone may answer why more carbon dioxide was secured by him. In two of our preliminary tests we first pumped off the gas, which came with ease, collected it in a burette, and then began pumping again, when we obtained a larger percentage of carbon dioxide than we did in the first pumping; however, we did not carry out this work repeatedly, therefore cannot state with any degree of assurance that this will always follow. It was not our purpose to ascertain the amount of gas that may be obtained from milk, but rather to secure a qualitative estimation of any changes that may occur in milk under aëration.

To do this it became necessary to hold to the same time and temperature and pressure, as far as possible, while pumping the gas from the milk. After trying the temperature of the room in several tests, about 22° centigrade, the conclusion was reached that the yield in amount of gas in milk was reduced. This amount was greater than we could account for by the contraction of the gas due to a change in temperature; neither did we desire to heat the milk lest some change might occur. That heat increases the gas liberated from a definite amount of milk is proved by Thörner's (13) work where large amounts of gas were obtained from comparatively small amounts of milk. Taking milk at 37½° C. or thereabouts it is believed that the milk does not undergo any change and that the greatest amount of gas could be obtained without altering the milk.

Furthermore it was also found necessary, after the preliminary tests, to limit the time of pumping because at no time was the milk totally exhausted, although most of the gas passed off within fifteen minutes after pumping began. The time limitation was fixed arbitrarily at one hour, believing that this limitation practically precluded the possibility of fermentation.

A pressure of 756 mm. to 759 mm. was recorded upon the manometer of the Geissler pump and from these have been deducted the errors in measurement resulting from vapor tension, yielding the results recorded. With three constants, which influence the amount of gas under our control, we were able to obtain fairly uniform results. There was, however, an error creeping in occasionally due to the presence of obstructions in the upright capillary tube connecting with the container. In this respect the apparatus designed is not as perfect as it should be, for mercury would sometimes fail to be drawn over from the capillary tube extending from the container to the horizontal portion of the arm, and thus interfere with the suction power of the pump upon the milk. I have given in two or three instances the analyses of very small amounts of gas; the explanation for these small amounts will be found in such obstructions. Whenever they occurred they could easily be detected while pumping.

Pflüger in his studies has made reference to the possible atmospheric source of some oxygen and nitrogen as found in milk and places himself against such a view. Both in his work and in our analyses this relationship is not established, therefore his views are upheld. The percentage of oxygen falls far below that of the air and even below the solubility of oxygen in water. The percentages of oxygen obtained from unexposed milk are

2.88, 3.09, 2.69, 2.14, 1.6, 2.12.

These figures represent mere traces of oxygen when viewed in the light of percentage of gas volume obtained instead of milk volume, which has not been employed in the estimation of any of our percentages. The following are the percentages of oxygen in its relation to total gas less carbon dioxide; however were these figures the solubilities

---

(13.) Chemiker Zeitung, 1894, Bd. XVIII.

of these two gases, oxygen and nitrogen only, as in air, the oxygen should exist in the ratio of 33.9:66.1 to nitrogen according to Bunsen:

10.29, 14.09, 14.70, 11.86, 8.06, 15.26.

There is only one possible way of explaining the presence of oxygen in the gas-content of milk. It is barely possible that some oxygen may be accounted for by its creeping in through its adherence to the mercury and walls of the container; however, when an attempt is made to secure it in pumping in the absence of milk not an appreciable trace of gas can be obtained. This ought to demonstrate that the oxygen is inherent in the milk.

It may be also well worth considering the fact that the cow used for this purpose received very little exercise; she was confined to her stall most of the time. There may be some relation existing between the carbon dioxide and the oxygen of milk due to the amount of exercise of the animal caused by a reduction in the metabolism of the body cells. I call attention to this as a possible answer to the variation in the gas constituents of the milk.

After ascertaining the gas-content of milk before it has been exposed to the air, it became necessary, in order to fully understand the changes in the gas-content of milk, to next study the gases of milk immediately after milking.

V. ANALYSES OF THE GAS-CONTENT OF MILK DIRECTLY AFTER MILKING.

The milk was secured in the ordinary way by milking into an open receptacle, thus allowing the milk to become exposed to the air in an open stream from the milk-duct to the receptacle; further, there was the churning action taking place as the streams impinged against the surface, which also exerts a marked influence in bringing the air in contact with the milk, because by this method much air is carried down into the milk. It has been found that it takes a few minutes after milking before the perceptible air bubbles rise to the surface. The surface of the milk in the receptacle also offered an opportunity for a considerable interchange of gases between the milk and the air.

Immediately after milking the milk was taken to the laboratory and placed in the same container as in the previous analyses, and the gas was obtained in identically the same manner.

Thörner (14) has made some analyses of the gas obtained from milk immediately after milking, but he employed heat to drive off the gases. The amount of gas which he obtained was much larger than in our case and his results were usually higher in carbonic acid gas, possibly due to his methods. I take the liberty to quote several of his analyses of milk directly after milking:—

Amount of gas per L.	Per cent of CO_2.	Per cent of Oxygen.	Per cent of Nitrogen.	
57.0	61.6	6.4	32.0	Open to air.
85.6	73.0	5.2	21.8	Open to air.
84.5	72.8	4.4	22.8	Open to air.
68.2	70.7	4.8	24.5	Open to air.
78.6	71.7	4.7	23.6	Open to air.
64.0	65.6	7.6	27.1	Open to air.
63.0	65.0	10.0	25.0	Open to air.
57.0	55.5	11.1	33.4	Open to air.
80.0	72.8	4.4	22.8	Open to air.
68.0	70.7	4.8	24.5	Open to air.
78.6	71.7	4.7	23.6	Open to air.

(14.) Loc. cit.

In considering the work of Thörner it is necessary to have in mind the method employed by him in securing gas from milk. Inasmuch as we had reached the conclusion that a high temperature increased the amount of gas obtained from a definite quantity of milk and that probably the carbon dioxide is with difficulty released upon pumping, issue must be taken with the results of Thörner. Further it has been demonstrated that other gases as hydrogen sulphide may be generated by boiling milk.

The high percentages of carbon dioxide indicates that heat may have facilitated the dissociation of carbon dioxide whether in solution or loose combination to that extent that a higher percentage of carbon dioxide and a lower percentage of oxygen were the results. It is well known carbon dioxide is with difficulty liberated in the presence of certain salts as $CaCO_3$, $Na_2 HPO_4$, and others (Setchenow). At any rate as our tables will show, Thörner's average of percentages differs materially from ours, although it falls considerably below milk which has not been exposed to the air.

Blyth (15) in his analysis of the gas-content of milk immediately after milking obtained a very low amount of carbon dioxide. His analysis is,

Carbon dioxide	.06 cc.	3.27 per cent.
Nitrogen	1.42 "	77.60 " "
Oxygen	.35 "	19.13 " "

The results obtained by him in no way can be reconciled with the results of Thörner or with the results which we secured. He has shown the possibility of the development of carbon dioxide after fermentation has begun, but it appears incredible that he should have gotten such a low percentage of carbon dioxide from fresh milk.

Our analyses are as follows:—

TABLE II.

Sample.	I.	II.	III.	IV.	V.	VI.
Date	Nov. 29th.	Nov. 30th.	Dec. 2d.	Dec. 4th.	Dec. 6th.	Dec. 7th.
Began milking at	7:35 a. m.	7:25 a. m.	7:30 a. m.	7:35 a. m.	7:35 a. m.	7:45 a. m.
Completed milking at	7:45 a. m.	7:35 a. m.	7:40 a. m.	7:45 a. m.	7:45 a. m.	7:55 a. m.
Began pumping at	9:00 a. m.	8:35 a. m.	8:30 a. m.	9:00 a. m.	8:40 a. m.	8:50 a. m.
Completed pumping at	10:15 a. m.	9:35 a. m.	9:30 a. m.	10:15 a. m.	9:40 a. m.	9:50 a. m.
Temperature when pumping	37.6°	38°	38°	38°	37.8°	37.5°
Barometric pressure in mm	688.6	690.63	690.63	696.6	698.6	692.84
Total gas in c. cm	6.62	6.84	5.96	2.70	6.64	5.5
Carbon dioxide in c. cm	3.82	3.78	3.47	1.78	4.35	2.93
Per cent. of carbon dioxide	59.31	55.33	58.27	66.1	65.65	53.28
Oxygen in c. cm	.91	.86	.84	.32	.727	.85
Per cent. oxygen	13.79	12.66	14.17	11.89	10.96	15.57
Residual gas in c. cm	1.78	2.19	1.64	.59	1.55	1.71
Per cent. residual gas	26.9	32.01	27.56	22.01	23.39	31.15

In the study of the above tables it will be found that the percentage of the gases in milk have undergone a change in the milking process itself. The carbon dioxide has been reduced and the oxygen increased. The six analyses of the gas-content of milk before exposure to the air give the following percentages in carbon dioxide:

80.58, 78.35, 81.73, 81.97, 80.16 and 86.19.

The average of the six analyses is 81.49⅔ per cent.

(15.) Foods, Their Composition and Analysis, 4 Ed., p. 251.

In the case of carbon dioxide immediately after milking, six analyses give in percentages

59.31, 55.33, 58.27, 66.1, 65.65 and 53.28.

The average of these is 59.63⅔ per cent.

The oxygen content has also undergone a marked change by the process of milking as compared with non-exposure to the air. We obtained as the oxygen content of milk in six analyses,

2.88, 3.09, 2.69, 2.14, 1.6 and 2.12 per cent.

The average of these is 2.42 per cent.

After the milk had been exposed to the air by the process of milking there was obtained,

13.79, 12.66, 14.17, 11.89, 10.96 and 15.57.

The average of these is 13.17⅔ per cent. There has therefore been an increase in the oxygen content of milk after milking over the oxygen content of unexposed milk of 10.75⅔ per cent. Further the percentages of residual gas drawn from the udder without exposure to the air is

16.54, 18.56, 18.27, 15.89, 18.24 and 11.71.

The average of these is 16.53½ per cent. After the milking process the percentages of residual gas are in six analyses,

26.9, 32.01, 27.56, 22.01, 23.39 and 31.15.

The average of these is 27.17 per cent, a gain of 10.63½ per cent in the residual gas over the residual gas in unexposed milk. There was a gain of oxygen and residual gas of 10.75⅔ per cent and 10.63½ per cent respectively, or in all 21.39⅙ per cent. There was a loss of 21.84 per cent in the case of carbon dioxide. Therefore, we find that these averages practically offset each other.

The percentages of oxygen to total gas less carbon dioxide in milk unexposed to the air were in six analyses

10.29, 14.09, 14.70, 11.86, 8.06 and 15.26 per cent.

After milking the percentages of oxygen to total gas less carbon dioxide are in six analyses

33.83, 28.19, 33.88, 25.16, 32.16 and 31.96 per cent.

From an examination of these two sets of results assuming that we are considering the relation of oxygen to nitrogen as they exist in the air it will at once be noticed that there has been a decided interchange in the relationship of oxygen to total gas less carbon dioxide due to change of gases between the air and milk during the process of milking; further, these two sets indicate that there is a chemical change going on rather than a mere mixing of air and milk, because we should expect that were it a mere solubility of oxygen and residual gas (perhaps nitrogen) the relationship would be as 33.9 to 66.1 as has been stated.

VI. ANALYSES OF GAS-CONTENT OF MILK DIRECTLY AFTER AËRATING OVER GLASS.

To understand what is effected by aëration a study of the gas-content of milk was made after it had been subjected to a specially devised process of aëration. The common methods of aëration were not employed on account of our inability to cope with the necessary requirements of such experiments with the facilities at hand. It would be absolutely essential that in such methods, a milk should be used under our control from the time it leaves the udder, and the aëration should also have to be under our direct supervision. Since such methods were ruled out from necessity, we resorted to methods which would simulate the methods in vogue as closely as possible.

A piece of glass six feet long by two inches wide was placed on an inclined board at an angle of about twenty degrees. Over this the milk was run drop by drop, making a film approximately of the extent of surface as indicated in the table. The amount of milk aërated during the process is also given. Room temperature varying from 18° to 20° C. was employed during aëration and was found to be the only temperature which could be satisfactorily used unless a special plant for aërating were constructed. The analyses of gases obtained from milk aërated over glass were conducted the same as with milk after milking.

TABLE III.

Sample.	I.	II.	III.	IV.	V.	VI.
Date	Dec. 3d.	Dec. 5th.	Dec. 12th.	Jan. 3d.	Jan. 4th.	Jan. 6th.
Began milking at	7:25 a. m.	7:30 a. m.	8:20 a. m.	8:00 a. m.	7:50 a. m.	7:45 a. m.
Completed milking at	7:38 a. m.	7:40 a. m.	8:30 a. m.	8:15 a. m.	8:00 a. m.	8:00 a. m.
Began aërating at	7:45 a. m.	7:50 a. m.	8:40 a. m.	9:00 a. m.	8:45 a. m.	9:28 a. m.
Completed aërating at	8:50 a. m.	8:45 a. m.	9:40 a. m.	10:00 a. m.	9:45 a. m.	10:28 a. m.
Began pumping at	9:25 a. m.	9:10 a. m.	10:00 a. m.	10:30 a. m.	10:22 a. m.	11:15 a. m.
Completed pumping at	10:25 a. m.	10:10 a. m.	11:00 a. m.	11:30 a. m.	11:12 a. m.	12:15 p. m.
Barometric pressure in mm	692.632	698.632	688.632	703.772	702.632	688.632
Temperature of water in tank	38°	38°	38°	36°	38°	38°
Total gas in c. cm	6.0948	4.2344	5.3384	4.1727	4.8757	6.9394
Free carbon dioxide in c. cm	2.3818	1.4418	2.0670	1.4287	2.4198	3.3107
Per cent. carbon dioxide	39.08	34.05	38.72	34.24	49.63	47.71
Free oxygen in c. cm	1.3743	.9908	1.1130	.9300	.8664	1.1561
Per cent. oxygen	22.55	23.4	20.85	22.29	17.77	16.66
Residual gas in c. cm	2.3385	1.8017	2.1583	1.8138	1.58	2.4725
Per cent. of residual gas	38.37	42.55	40.43	43.47	32.60	35.63
Amount of milk aërated in c. cm	850	700	570	700	565	700
Extent of surface approximately	1½ inches.	1½ inches.	1½ inches.	1½ inches.	1½ inches.	1½ inches.

In these tables the percentages of carbon dioxide are
39.08, 34.05, 38.72, 34.24, 39.63 and 47.71.

The average of these is 40.57⅙ per cent.

This represents a loss of 19.06⅚ per cent of carbon dioxide by aërating over glass, for the percentages of carbon dioxide after milking were
59.31, 55.33, 58.27, 66.1, 65.65 and 53.28.

The average of these is 59.63⅔.

The percentages of oxygen obtained by aëration are
22.55, 23.4, 20.85, 22.29, 17.77, 16.66.

The average of these is 20.58⅔ per cent.

In the case of milk directly after milking the percentages of oxygen were
13.79, 12.66, 14.17, 11.89, 10.96 and 15.57.

The average of these is 13.17⅔ per cent.

This represents a gain of 7.41 per cent in the oxygen constituent of aërated milk over milk which has not been aërated.

The residual gas exists in the following percentages in the aërated milk,
38.37, 42.55, 40.43, 43.47, 32.60 and 35.63.

The average of these is 38.84⅙ per cent.

In milk after milking,
26.9, 32.01, 27.56, 23.01, 23.39, 31.15.

The average of these is 27.17 per cent.

It thus follows that the residual gas has increased 11.67⅙ per cent.

After milking the percentages of oxygen to total gas less carbon dioxide are
33.83, 28.19, 33.86, 35.16, 32.16 and 31.96.

The average of these is 32.53 per cent.

After aërating the percentages are
37.01, 35.44, 34.00, 33.89, 35.45 and 31.86.

The average of these is 34.60⅚, a gain of 2.07⅚ per cent by aëration.

VII. ANALYSES OF GAS-CONTENT OF MILK AFTER AËRATION OVER TIN, COPPER AND THROUGH GLASS WOOL AND COPPER SIEVES.

It was thought advisable to test different materials in place of glass inasmuch as it is well established that some metals have an influence upon oxidation. The next two tables will indicate the value of aëration over tin or copper. The last table is the result of an attempt to break up the drops of milk by passing the drops through copper sieves and through glass wool three inches thick. The drops passing in all through six feet of air before reaching the receptacle, the materials mentioned above intervening.

It was found very difficult to operate this combination of air sieves and glass wool satisfactorily so as to obtain uniform results. The trouble lay in the fact that sometimes the drops could be thoroughly shattered and at other times small streams would form.

TABLE IV. (Over tin.)

Sample.	I.	II.	III.	IV.	V.
Date	Dec. 20th.	Dec. 21st.	Dec. 23d.	Dec. 28th.	Jan. 7th.
Began milking at	7:40 a. m.	7:45 a. m.	7:45 a. m.	7:35 a. m.	7:40 a. m.
Completed milking at	7:50 a. m.	8:00 a. m.	8:00 a. m.	7:48 a. m.	7:50 a. m.
Began aërating at	7:55 a. m.	8:05 a. m.	8:05 a. m.	7:55 a. m.	8:45 a. m.
Completed aërating at	8:55 a. m.	9:05 a. m.	9:05 a. m.	8:55 a. m.	9:45 a. m.
Began pumping at	9:30 a. m.	9:30 a. m.	9:25 a. m.	9:18 a. m.	10:15 a. m.
Completed pumping at	10:30 a. m.	10:30 a. m.	10:25 a. m.	10:18 a. m.	11:15 a. m.
Barometric pressure in mm	695.265	696.632	678.632	688.672	687.242
Temperature of water in tank	38.5°	37.8°	37.9°	38°	37.2°
Total gas in c. cm	4.4822	6.4969	6.7922	6.9385	6.6669
Free carbon dioxide in c. cm	1.8874	1.8561	1.5900	2.4485	2.9854
Per cent. carbon dioxide	42.11	28.57	23.41	35.29	44.78
Free oxygen in c. cm	.8541	1.4715	1.7489	1.4057	1.0320
Per cent. of oxygen	18.61	22.65	25.75	20.26	15.48
Residual gas in c. cm	1.7606	3.1691	3.4531	3.0841	2.6494
Per cent. of residual gas	39.28	48.78	50.84	44.45	39.74
Amount of milk aërated	1,000 c.cm.	600 c.cm.	565 c.cm.	800 c.cm.	560 c.cm.
Extent of surface approximately	¾ inch.	2½ inches.	2½ inches.	1½ inches.	1½ inches.

TABLE V. (Over copper.)

Sample.	I.	II.	III.	IV.	V.
Date	Dec. 10th.	Dec. 12th.	Dec. 19th.	Dec. 24th.	Dec. 26th.
Began milking at	7:30 a. m.	7:35 a. m.	7:50 a. m.	7:30 a. m.	7:35 a. m.
Completed milking at	7:40 a. m.	7:45 a. m.	8:00 a. m.	7:45 a. m.	7:50 a. m.
Began aërating at	7:45 a. m.	7:48 a. m.	8:10 a. m.	7:55 a. m.	8:00 a. m.
Completed aërating at	8:40 a. m.	9:00 a. m.	9:10 a. m.	8:55 a. m.	9:00 a. m.
Began pumping at	9:40 a. m.	9:30 a. m.	9:35 a. m.	9:25 a. m.	9:30 a. m.
Completed pumping at	10:40 a. m.	10:30 a. m.	10:35 a. m.	10:25 a. m.	10:30 a. m.
Barometric pressure in mm	690.632	696.937	696.937	686.632	690.632
Temperature of water in tank	38°	37.5°	37.6°	38°	37.8°
Total gas in c. cm	.6349	5.0379	3.4637	4.4236	3.4411
Free carbon dioxide in c. cm	.136	2.638	1.516	1.837	1.8110
Per cent. carbon dioxide	21.43	52.25	43.79	41.54	52.63
Free oxygen in c. cm	.205	.725	.588	.589	.3169
Per cent. of oxygen	32.34	14.41	16.99	13.33	9.21
Residual gas in c. cm	.293	1.679	1.358	1.99	1.3131
Per cent. of residual gas	46.23	33.34	39.22	45.13	38.16
Amount of milk aërated	1 L.	1 L.	½ L.	½ L.	1 L.
Extent of surface approximately	2½ inches.	1½ inches.	½ inch.	1½ inches.	1½ inches.

TABLE VI. (Through glass wool.)

Sample.	I.	II.	III.	IV.
Date	Nov. 11th.	Nov. 25th.	Nov. 26th.	Dec. 27th.
Began milking at	7:40 a. m.	7:35 a. m.	7:25 a. m.	7:45 a. m.
Completed milking at	7:50 a. m.	7:45 a. m.	7:35 a. m.	7:55 a. m.
Began aërating at	8:30 a. m.	8:00 a. m.	7:45 a. m.	8:00 a. m.
Completed aërating at	9:30 a. m.	9:00 a. m.	8:45 a. m.	9:00 a. m.
Began pumping at	9:45 a. m.	9:25 a. m.	9:30 a. m.	9:35 a. m.
Completed pumping at	10:45 a. m.	10:25 a. m.	10:30 a. m.	10:35 a. m.
Barometric pressure in mm	722.3932	690.632	697.265	694.632
Temperature of water in tank	22.8°	37.8°	38.5°	38°
Total gas in c.cm	4.0405	2.5399	4.9704	5.4427
Free carbon dioxide in c.cm	.5385	.5440	1.5810	1.9952
Per cent. of carbon dioxide	13.33	21.42	31.81	36.66
Free oxygen in c.cm	1.0771	.7711	.9940	.8844
Per cent. of oxygen	26.66	30.36	20.00	16.25
Residual gas in c.cm	2.4247	1.2247	2.3952	2.5629
Per cent. of residual gas	60.01	48.22	48.19	47.09
Amount of milk aërated in c.cm	560.	600.	750.	1.050

The studies of aëration as compared with unexposed milk and milk directly after milking can profitably be presented at this stage. The percentages of carbon dioxide are in unexposed milk
80.58, 78.35, 81.75, 81.97, 80.16, 86.19;
in milk after milking
59.31, 55.33, 58.27, 66.1, 65.65, 53.28;
in milk after aëration
over glass,
39.08, 34.05, 38.72, 34.24, 49.63, 47.61;
over tin
42.11, 28.57, 23.41, 35.29, 44.78;
over copper,
21.43, 52.25, 43.79, 41.54, 52.63;
through glass wool and copper sieves,
13.33, 21.42, 31.81, 36.66.

The averages of these are

in unexposed milk	81.496	per cent.
in milk after milking	59.636	“ “
in milk after aëration		
over glass	40.572	“ “
over tin	35.832	“ “
over copper	42.328	“ “
through glass wool and copper sieves	25.805	“ “

In the case of oxygen the percentages are,
in an unexposed milk,
2.88, 3.09, 2.69, 2.14, 1.6, 2.12;
in milk directly after milking,
13.79, 12.66, 14.17, 11.89, 10.96, 15.57;
in milk after aëration
over glass,
22.55, 23.4, 20.85, 22.29, 17.77, 16.66;
over tin,
18.61, 22.65, 25.75, 20.26, 15.48;
over copper,
32.34, 14.41, 16.99, 13.33, 9.21;
through glass wool and copper sieves,
13.33, 21.42, 31.81, 36.66.

The averages of these are

in unexposed milk	2.42	per cent.
in milk directly after milking	13.176	“ “
in milk after aëration		
over glass	20.586	“ “
over tin	20.55	“ “
over copper	17.256	“ “
through glass wool and copper sieves	25.805	“ “

The residual gas has the following percentages:
in unexposed milk,
16.34 18.56, 18.27, 15.89, 18.24, 11.71;
in milk after milking,
26.9, 32.01, 27.56, 22.01, 23.39, 31.15;
in milk after aëration
over glass,
38.37, 42.55, 40.43, 43.47, 32.60, 35.63;
over tin,
39.28, 48.78, 50.84, 44.45, 39.74;
over copper,
46.23, 33.34, 39.22, 45.13, 39.16;
through glass wool and copper sieves,
60.01, 48.22, 48.19, 47.09.

The averages of these are

in unexposed milk	16.535 per cent.
in milk directly after milking	27.17 “ “
in milk after aëration	
over glass	38.842 “ “
over tin	44.618 “ “
over copper	40.416 “ “
through glass wool and copper sieves	50.8775 “ “

The relation of oxygen to residual gas is best shown by the determination of percentages of oxygen to the residual gas plus oxygen. This is done to bring out any atmospheric relationship.

Percentages in case of
unexposed milk,
10.29, 14.09, 14.70, 11.86, 8.06 and 15.26;
milk after milking,
33.83, 28.19, 33.88, 35.16 and 31.96;
milk after aëration
over glass,
37.01, 35.44, 34.00, 33.89, 35.45, 31.86;
over tin,
32.14, 31.70, 33.61, 31.30, 28.05;
over copper,
46.16, 30.15, 30.21, 22.83, 19.44;
through glass wool and copper sieves,
30.75, 38.60, 29.32, 25.65.

The average percentages are

in unexposed milk	12.376
in milk directly after milking	32.53
in milk after aëration	
over glass	33.94
over tin	31.16
over copper	29.76
through glass wool and copper sieves	31.13

We gather from these studies that after the milk leaves the udder of the cow there is a diminution in the amount of carbon dioxide and an increase in oxygen to a certain low percentage which is dependent upon the thoroughness with which the milk is brought in contact with the air. From the extreme results it is evident there has been a falling off in carbon dioxide of 73.86 per cent and an increase of 35.06 per cent of oxygen, thus indicating that there is no equi-volumetric interchange. Even the average results show no intimate relationship between the oxygen and carbon dioxide. This may, however, be due to the difference in the solubilities of the gases, carbon dioxide being dissolved volume for volume, while oxygen enters only comparatively meagerly into solution, about four per cent by volume. It would be possible by the direct determination of carbon dioxide in milk before the beginning of fermentation to say to what extent the milk has been aërated.

Further studies of the gases of milk and their interchange will reveal other aspects of the subject.

VIII. NO APPRECIABLE INTERCHANGE OF GASES BETWEEN STERILIZED MILK AND THE AIR CONFINED OVER IT.

In six experiments an attempt was made to ascertain whether or not there was a decrease in the amount of oxygen in the air confined over sterilized milk and a development of carbon dioxide. Liter flasks were taken and 500 c. cm. of fresh milk was added and sterilized on three consecutive days for one hour each day. They were then sealed with sterilized rubber stoppers through the single perforations of which passed two way stop-cock tubes by means of which the air content could be drawn at will. Besides the rubber stopper seal, a mercury seal was made about the rubber stopper by wiring a rubber tube about the neck of the flask and allowing it to reach above the rubber stopper where it was cut off. This formed a cup shaped envelope for the stopper and could be filled with mercury to cover the rubber stopper completely. Through the glass tube the air-content of the flask could be removed easily at will and analyzed without the possibility of extraneous air entering.

Six analyses of air from different flasks made within a period of six weeks showed no appreciable difference from that of the extraneous air used as check.

IX. *ACTION OF SPECIFIC MICRO-ORGANISMS UPON THE INTERCHANGE OF GASES BETWEEN MILK AND AIR.

It becomes necessary, after a review of the gas-content of milk when unexposed to the air, when exposed to the air by milking, and by the process of aëration, to consider what influences fermentation may have.

Of course it is well understood that micro-organisms are capable of producing different gases, yet we have felt it obligatory to make some specific studies in this connection. Consequently several micro-organisms isolated from milk and known by their laboratory numbers were used to inoculate sterilized milk and the flasks sealed as described under V.

It will at once be recognized that no attempt has been made to determine any other gases which may be present than carbon dioxide and oxygen because with these alone are we mostly concerned. Hydrogen and marsh gas were determined in several instances and the results obtained were included with the total residual gas.

In most analyses, it is worthy of emphasis, there have been noticeable decreases in the amount of oxygen and increases in carbon dioxide. This, however, is not universally true because in No. 121 there has been no production of carbon dioxide and the oxygen has been but little reduced. In No. 126 there are no traces of carbon dioxide and still the oxygen has been practically consumed. In short there is a wide diversity of action, each micro-organism seems to be governed by its own peculiar functions. As a rule, however, there seems to be sufficient proof that carbon dioxide is a common product of these micro-organisms and that oxygen is consumed to a greater or less degree.

---

* See description of bacteria on page 284.

TABLE VII.

STUDY OF INTERCHANGE OF GASES CONFINED OVER MILK INOCULATED WITH SPECIFIC MICRO-ORGANISMS.

Culture of Micro-Organisms.	No. 119.	No. 120.	No. 121.	No. 122.	No. 123.	No. 124.	No. 125.	No. 126.	No. 128.	No. 129.	No. 130.
Date of sample	Aug. 28	Aug. 28	Aug. 28	Aug. 28	Aug. 28	Aug. 28	Aug. 25	Aug. 28	Aug. 28	Aug. 28	Aug. 28
Date of analysis	Sept. 23	Sept. 24	Sept. 23	Sept. 26	Oct. 10	Sept. 28	Oct. 2	Oct. 18	Oct. 10	Oct. 15	Oct. 23
Amount of milk used in c.cm	100	100	100	100	100	100	100	100	100	100	100
Amount of air space over milk in c.cm	225	217	220	220	216	221	179	213	225	213	218
Amount of gas examined in c.cm	35.8	27.0	26.0	26.8	21.85	28.2	23.6	30.65	31.15	21.35	19.00
Amount of carbon dioxide in c.cm	3.4	16.0	0	15.4	1.25	12.8	2.2	.0	7.45	.1	2.2
Per cent. of carbon dioxide	9.49	59.25	0	57.46	5.72	45.39	9.32	.0	23.91	.47	11.052
Amount of oxygen in c.cm	1.0	0	4.6	0	0	0	0	1.50	.2	.05	1.2
Per cent. of oxygen	2.79	0	17.69	0	0	0	0	.42	.6	.20	6.315
Amount of residual gas in c.cm	31.4	11.0	21.4	11.4	26.60	15.4	21.4	29.35	23.5	21.20	15.6
Per cent. of residual gas	87.72	40.75	82.31	42.54	94.28	54.61	90.63	99.995	76.08	99.33	82.633

X. THE INTERCHANGE OF GASES BETWEEN MILK FRESH FROM THE COW AND CONFINED AIR.

To ascertain whether changes indicated above took place fresh milk was taken and flasked as in the previous experiments and after a time the confined air analyzed.

However, before detailing the results of these experiments it may be desirable to quote the work of Dr. Felix Hoppe ("Arch. f. Path. Anat. u. Physiol. u. f. klinische Medicin" Bd. 17, S. 417, (1859) whose results are as follows:—

Sample.	Vol. of air.	Vol. of milk.	Per cent of CO^2.	Per cent of oxygen.	Per cent of nitrogen.	Hours confined together.
I	588	500	6.08	13.03	80.89	24
II	228	100	13.30	8.40	78.30	24
III	178	150	15.99	8.39	75.62	24
IV	185	140	10.94	12.64	76.42	24
V	156	140	35.95	0	64.05	96
VI	175	150	33.05	0	66.95	96
VII	289	185	28.58	3.76	67.66	96

E. Mathieu and D. Urbain (Compt. rend. 75, 1482) have the following experiments which indicate an interchange of carbon dioxide and oxygen when air is confined over milk:

10 c. cm. of milk was employed
at 10° C.

	In 2 hours.	In 18 hours.	In 48 hours.	In 3 days.	In 8 days.
Oxygen absorbed in c.cm	0.9	1.32	1.75	2.46	5.66
Carbon dioxide giving off c.cm	traces.	0.40	1.2	2.20	6.00

	At 18° C.	At 32° C.
	In 24 hours.	In 24 hours.
Oxygen absorbed in c.cm	2.62	5.00
Carbon dioxide given off in c.cm	3.21	5.82

Our results are as follows:—

TABLE VIII.

(Sample A.)

Amount of milk confined=1040 c. cm.
Amount of air space over milk=520 c. cm.
Temperature at which sample was maintained=37½° C.

	After 16 hours.		After 40 hours.		After 88 hours.	
Amount of gas analyzed	29.8 c.cm.		26.4 c.cm.		48.5 c.cm.	
	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.
Carbon dioxide	1.8	6.04	3.6	13.63	10.1	20.83
Oxygen	4.6	15.47	1.0	3.79	0.0	0.0
Residual gas	22.0	78.49	21.8	82.58	38.4	79.17

(Sample B.)

Amount of milk confined=985 c. cm.
Amount of air space over milk=747 c. cm.
Temperature at which sample was maintained=37½° C.

	After 16 hours.		After 45 hours.		After 112 hours.	
Amount of gas analyzed	37.2 c.cm.		35.6 c.cm.		38.68 c.cm.	
	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.
Carbon dioxide	1.2	3.84	7.6	21.35	17.4	55.08
Oxygen	5.4	17.31	1.2	3.37	0.0	0.0
Residual gas	24.6	78.85	26.8	75.28	21.2	44.92

(Sample C.)

Amount of milk confined=905 c. cm.
Amount of air space over milk=750 c. cm.
Temperature at which sample was maintained=21° C.

	After 18½ hours.		After 42½ hours.		After 91 hours.	
Amount of gas analyzed	33.0 c.cm.		32.6 c.cm.		32.8 c.cm.	
	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount. of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.
Carbon dioxide	.5	1.51	1.4	4.29	6.4	19.51
Oxygen	6.6	20.0	5.6	17.18	.2	.6
Residual gas	25.9	78.49	25.6	78.53	26.2	79.89

(Sample D.)

Amount of milk confined=805 c. cm.
Amount of air space over milk=770 c. cm.
Temperature at which sample was maintained=10° C.

	After 22 hours.		After 47 hours.		After 118 hours.	
Amount of gas analyzed	30.2 c.cm.		24.4 c.cm.		9.4 c.cm.	
	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.
Carbon dioxide	.2	.66	.2	.8	2.	2.13
Oxygen	6.2	20.5	5.0	20.49	1.6	17.0
Residual gas	23.8	78.8	19.2	78.71	7.6	80.86

(Sample E.)

Amount of milk confined=835 c. cm.
Amount of hydrogen over the milk=915 c. cm.
Temperature at which sample was maintained=37½° C.

	After 19 hours.		After 39½ hours.		After 114 hours.	
Amount of gas analyzed	32.0 c.cm.		33.6 c.cm.		37.2 c.cm.	
	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.
Carbon dioxide	.6	1.88	2.4	6.55	25.2	67.71
Oxygen	0.0	0.0	0.0	0.0	0.0	0.0
Residual gas	31.4	98.12	31.2	93.45	12.	32.29

(Sample F.)

Amount of milk confined=1240 c. cm.
Amount of hydrogen over milk=475 c. cm.
Temperature at which sample was maintained=21° C.

	After 21 hours.		After 42½ hours.		After 94 hours.	
Amount of gas analyzed	29.4 c.cm.		33.2 c.cm.		42.0 c.cm.	
	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.	Amount of gas obtained in c.cm.	Per cent. of gas by vol.
Carbon dioxide	.2	.69	.5	1.5	2.8	6.66
Oxygen	.2	.69	.5	1.5	0.0	0.0
Residual gas	29.0	98.62	32.2	97.00	39.2	93.34

These tables confirm the work with specific micro-organisms and demonstrate that there is no uniformity in the results obtained on studying the interchange of gases due to the fermentations induced by bacteria. Usually oxygen entirely disappears and carbon dioxide increases in amount, still it is found that traces of oxygen remain in some cases of air confinement over milk even after many hours. Unless there is inducted fermentation, there can be no elimination of carbon dioxide and decrease of oxygen. Further, after milk reaches an age where bacterial growth is abundant there can be no correct study of the gas-content of milk.

Thörner and Blyth have further demonstrated that as fermentation sets in the carbon dioxide increases and oxygen may totally disappear.

It is apparent therefore that micro-organisms enter intimately into the production of carbon dioxide and the absorption of oxygen after fermentation begins. This may be checked by the use of antiseptics in milk.

XI. ACTION OF ANTISEPTICS UPON THE INTERCHANGE OF GASES BETWEEN MILK AND AIR CONFINED OVER IT.

Attempts were made employing chloroform, ether, formaldehyde, but without success because of their interference with the gas analyses.

Mercuric chloride and salicylic acid were also used but they were not satisfactory.

Lysol gave us the most trustworthy results.

TABLE IX.

ACTION OF LYSOL UPON GASEOUS INTERCHANGE IN MILK.

Sample.	A.		B.		C.		D.		E.		F.	
Time before analysis	90 hours.		13 days.		20 days.		28 days.		29 days.		90 hours.	
Per cent. of lysol used	½		2		1.		1.		2.		Control.	
Temperature of sample	37½		Room.		Room.		Room.		Room.		37½	
Amount of gas analyzed	30.6 c.cm.		17.4 c.cm.		28.6 c.cm.		31.6 c.cm.		45.4 c.cm.		37.0 c.cm.	
	Amount of gas obtained in c.cm.	Per cent. of gas per volume.	Amount of gas obtained in c.cm.	Per cent. of gas per volume.	Amount of gas obtained in c.cm.	Per cent. of gas per volume.	Amount of gas obtained in c.cm.	Per cent. of gas per volume.	Amount of gas obtained in c.cm.	Per cent. of gas per volume.	Amount of gas obtained in c.cm.	Per cent. of gas per volume.
Carbon dioxide	.4	1.31	.2	1.15	.2	.7	0	0	0	0	6.2	22.97
Oxygen	4.6	15.03	3.0	17.44	5.0	17.51	4.0	12.66	5.6	12.33	0	0
Residual gas	25.6	83.66	14.2	81.41	23.4	82.42	27.6	87.34	39.8	87.67	20.8	77.03
Amount of milk confined	1,000 c.cm.		250 c.cm.		500 c.cm.		500 c.cm.		250 c.cm.		1,000 c.cm.	
Amount of air space over sample	720 c.cm.		310 c.cm.		605 c.cm.		625 c.cm.		265 c.cm.		725 c.cm.	

From this we gather that some oxygen has been absorbed as is indicated by the lower percentage. It may be, however, that the carbon dioxide, had any been evolved, was absorbed by the alkalinity of the lysol. This element of error may be overcome by the use of trikresol, a neutral substance, which yielded these results:—

Five hundred c. cm. of fresh milk was placed in a liter flask to which was added one per cent of trikresol. The flask was then mercury sealed and placed away for twenty-five days. An analysis made of the gases confined over the milk resulted as follows:

Total amount of gas analyzed	19.6 c. cm.	
Carbon dioxide	0 c. cm.	0 per cent.
Oxygen	3.6 c. cm.	18.37 " "
Residual gas	16.0 c. cm.	81.63 " "

Here again the oxygen is gradually diminishing but no carbon dioxide appears to take its place as is the case with fermentation. The reason given for the failure of carbon dioxide to appear in the case of lysol will not hold with the neutral trikresol.

Milk to which lysol or trikresol has been added cannot be regarded as normal milk, yet from this work there is indicated an absorption of oxygen; carbon dioxide is not found present, but should normal conditions be maintained there is a possibility of its appearance. Furthermore what carbon dioxide exists in the milk as gas could with difficulty be detected by an analysis of the confined air over the milk.

XII. THE ACTION OF 100 PER CENT OF CARBON DIOXIDE UPON THE DEVELOPMENT OF BACTERIA.

From the results of the foregoing work with the gas-content of milk we are now led to a study of the influence of carbon dioxide upon micro-organisms, for it is a general and an indefinite belief that aëration has a direct bearing upon the bacterial life usually present in milk. Inasmuch as there is a high percentage of carbon dioxide in milk, it is probable that its presence might have some effect upon the development and increase of the bacteria found and thus change the course of possible milk fermentations. That carbon dioxide does exert an influence has been shown by Delbrück and Foth (16), Hansen (17), Ortloff (18). The gist of the conclusions reached by the experimental labors of these men, although not wholly in unison, is found in the restraining effect which carbon dioxide has upon the multiplying power of the yeast cell and upon its fermenting energy; also in its stimulating action upon the individual fermenting capacity of the yeast cell apparently in its search for an oxygen supply. For outward manifestations, there would appear only a restraint in fermentation development. To arrive at a comprehensive understanding of the situation in its most direct relation, carbon dioxide under varying conditions was employed to definitely ascertain its influence upon micro-organisms. In the first trial carbon dioxide in its free state was used to determine its direct bearing upon micro-organisms in plate cultures.

To accomplish this, two sets of plates as nearly identical as possible were made of the same micro-organisms; one set to be kept in the air and the other to be confined in Novy's anaërobic plating apparatus into which carbon dioxide was passed until the percentage reached one hundred. These plates were allowed to develop 48 hours or until they were thought to be fully developed, when the plates from the anaërobic apparatus were removed and both sets counted at the same time and closely compared. In all of this work pains-taking care was exercised to observe the most careful technique in securing exact conditions in every respect for the two sets of plate cultures studied—a single batch of media, the same diluted fresh bouillon culture, the same loop for measurement, the same environment during development excepting the factor, carbon dioxide,—all were brought under the closest scrutiny. The carbon dioxide used was generated from sodium carbonate and sulphuric acid. The results of these studies are tabulated below:—

(16.) Wochenschrift für Brauerei, 1887, p. 37.
(17.) Cent. f. Bakt. Bd. I, 1887.
(18.) Cent. f. Bakt. Bd. VI, S. 676, 721, 753.

. TABLE X.

No. of micro-organism.	Plates developed in 100% CO_2.		Plates developed in air as check.	
	Growth.	No. of colonies.	Growth.	No. of colonies.
119	......	......	......	......
120	† r. g.	4,400	* v. g.	4,570
121	‡ n. g.	......	v. g.	1,399
122	r. g.	7,549	v. g.	7,441
123	n. g.	......	v. g.	1,727
124	r. g.	525	v. g.	636
125	n. g.	......	v. g.	119
126	n. g.	......	v. g.	381
127	n. g.	......	v. g.	560
128	r. g.	3,650	v. g.	3,720
129	......	......	......	......
130	n. g.	......	v. g.	1,236
131	r. g.	3,434	v. g.	10,303
132	......	......	......	......
133	......	......	......	......
134	......	......	......	......

* v. g.—Vigorous normal growth of colonies.
† r. g.—Retarded growth of colonies.
‡ n. g.—No growth of colonies.

From the above table it will be readily noticed that 100 per cent of carbon dioxide has not only a marked retarding influence, but in some instances an inhibitory action where the germs have not grown at all. The retarding action was noticeable in the slow development of the colonies in the plates subjected to carbon dioxide, when in air duplicate colonies developed very rapidly. This restraining action is manifest in five out of eleven. The inhibitory action was determined by allowing the plates to develop in air after removal from the carbon dioxide atmosphere. This inhibitory action existed in six out of eleven. Total inhibition existed in Nos. 123, 125, 127. To what extent the amount of carbon dioxide may exercise any influence is of considerable interest, since we find a great variation in the carbon dioxide in milk as it undergoes the various operations of the dairy; consequently we have carried the work a little farther to ascertain the effect as the percentage is reduced.

XIII. DESCRIPTION OF MICRO-ORGANISMS.

The laboratory numbers used to represent the micro-organisms may be elucidated by reference to a table giving some identifying marks, although in the case of those bacteria obtained from milk directly, no attempt has been made to work out their life histories. They are in every case micro-organisms which have been found more or less constantly in the college dairy, have been used frequently in our laboratory work because of their frequency in the college dairy milk and are therefore representative of the class of "milk bacteria." A brief descriptive sentence is attached to each micro-organism to indicate in particular its action upon milk.

Our purpose in selecting a representative group of this nature for close study, was to gain not only information regarding the individual response of these germs to the studies undertaken, but also the results ensemble. An attempt was made to take ordinary market milk for these studies, but this after several trials was given up, because it gave no analytical significance in this application.

TABLE XI.

No. of micro-organism.	Description.
119	Orange pigment producing bacillus capable of peptonizing milk rapidly, after first curdling the milk.
120	Sours milk rapidly, curdling it and after standing for a long period slightly peptonizes it. It is a short bacillus. Gas is produced in abundance.
121	A short bacillus. No gas is produced. Gives rise to solid curd and large amount of acid, but does not cause peptonization of the milk.
122	Similar to No. 120. In some respects it differs but in general belongs to same type.
123	A long bacillus which peptonizes milk very rapidly. Curd formed before peptonization.
124	Gassy cheese germ described in Bulletin 183.
125	A long bacillus peptonizing milk very rapidly but different from 123 in many respects.
126	A coccoid bacillus producing no apparent change in milk.
127	A medium sized bacillus which dissolves casein rapidly without producing any distinct curd.
128	Of same type as numbers 120 and 122 but differing in details.
129	Hay bacillus—very weak. Stock culture.
130	Potato bacillus. Stock culture.
131	Colon bacillus. Stock culture.
132	Eberth bacillus. Stock culture.
133	Ropy cream bacillus as described in bulletin 140 of this station.
134	Hueppe's bacillus acidi latici. Stock culture.

XIV. THE ACTION OF 96.5 PER CENT OF CARBON DIOXIDE UPON THE DEVELOPMENT OF BACTERIA.

Table XII represents culture plates made in exactly the same way and allowed to develop under identically the same conditions as in Table X, with this exception, the carbon dioxide in the aërating apparatus was reduced to 96.5 per cent.

TABLE XII.

No. of micro-organism.	Plates developed in 96.5% CO_2.		Plates developed in air as check.	
	Growth.	No. of colonies.	Growth.	No. of colonies.
119	n. g.	....	v. g.	3,480
120	r. g.	2,040	v. g.	2,000
121	n. g.	....	v. g.	1,280
122	r. g.	2,640	v. g.	2,060
123	n. g.	....	v. g.	1,920
124	r. g.	1,650	v. g.	1,900
125	....	....	....	....
126	n. g.	....	v. g.	260
127	n. g.	....	v. g.	270
128	r. g.	3,000	v. g.	2,800
129	....	....	....	....
130	r. g.	200	v. g.	660
131	r. g.	1,200	v. g.	1,870
132	n. g.	....	v. g.	3,600
133	n. g.	....	v. g.	2,060
134	n. g.	....	v. g.	4,400

Again the retardation and inhibition of the growth of micro-organisms appear to be about the same as in Table X. No development occurred in 119, 121, 123, 126, 127, 132, 133, 134 or eight out of sixteen and 119, 123, 125, 127, 133 were wholly inhibited or even destroyed for they did not develop after exposure to air for 48 hours. The restraining influence therefore was exerted in every instance, extending to total inhibition or destruction in the cases cited.

XV. THE ACTION OF 62.9 PER CENT OF CARBON DIOXIDE UPON THE DEVELOPMENT OF BACTERIA.

Carrying this investigation still further we find in Table XIII the conditions identical with the previous tables but the carbon dioxide has been reduced to 62.97 per cent.

TABLE XIII.

No. of micro-organism.	Plates developed in 62.97% CO_2.		Plates developed in air as check.	
	Growth.	No. of colonies.	Growth.	No. of colonies.
119	n. g.	....	v. g.	5,434
120	r. g.	3,408	v. g.	3,280
121	r. g.	2,968	v. g.	4,346
122	r. g.	6,360	v. g.	6,140
123	n. g.	....	v. g.	3,230
124	r. g.	2,380	v. g.	2,475
125	....	....	....	....
126	n. g.	....	v. g.	969
127	n. g.	....	v. g.	1,720
128	r. g.	3,234	v. g.	3,432
129	....	....	....	....
130	r. g.	200	v. g.	953
131	r. g.	1,716	v. g.	2,108
132	n. g.	....	v. g.	7,000
133	n. g.	....	v. g.	4,865
134	n. g.	....	v. g.	2,529

Under the influence of 62.97 per cent of carbon dioxide we begin to find that upon some of the micro-organisms, as in the case of 121, the influence of carbon dioxide is not so marked as in the previous tables; and when, as in the case of Table XIV, the carbon dioxide has been reduced to 32.9 per cent, the restraining influence is but slight with most of the micro-organisms studied.

XVI. THE ACTION OF 32.9 PER CENT OF CARBON DIOXIDE UPON THE DEVELOPMENT OF BACTERIA.

TABLE XIV.

No. of micro-organism.	Plates developed in 32.9% CO_2.		Plates developed in air as check.	
	Growth.	No. of colonies.	Growth.	No. of colonies.
119	n. g.	....	v. g.	5,200
120	v. g.	2,880	v. g.	3,020
121	v. g.	402	v. g.	510
122	v. g.	1,540	v. g.	1,960
123	r. g.	2,060	v. g.	4,240
124	v. g.	900	v. g.	1,000
125	....	....	....	....
126	n. g.	....	v. g.	3,100
127	n. g.	....	v. g.	900
128	v. g.	412	v. g.	502
129	....	....	....	....
130	r. g.	1,420	v. g.	480
131	v. g.	1,800	v. g.	1,720
132	n. g.	....	v. g.	1,800
133	n. g.	....	v. g.	1,520
134	r. g.	560	v. g.	980

v. g. of CO_2 column is not so fully developed as v. g. in air and might be considered more correctly a good growth.

In most cases there is a vigorous growth which is noted in the table, yet this vigorous growth is not so far advanced as that in the air plates. The action of carbon dioxide is slight as compared with the preceding tables. While four out of fifteen have failed to develop, still six of the previously retarded have developed vigorously. Nos. 123 and 130 which have been so susceptible to the action of free carbon dioxide now present colonies of slow development only. The conclusion therefore to be drawn from this table is the amount of carbon dioxide used approximates the border line between carbon dioxide as it exists in an active form and where it begins to manifest little influence upon the development of bacteria.

It is noteworthy that the percentages of carbon dioxide which just inhibits stands so near to the percentages of carbon dioxide obtained from milk after the aërating methods have been employed as described in the foregoing pages. We are led to believe that some relationship exists between the carbon dioxide content of milk and the rate of fermentations evolved through the agency of bacteria. This conclusion will be more strongly enforced in the tables which follow.

XVII. THE ACTION OF CARBON DIOXIDE UPON BACTERIA WHEN CULTIVATED IN MILK.

To simulate the carbon dioxide content of milk, it became necessary to employ sterilized milk tubes into which were inoculated the various micro-organisms under consideration and to subject one set of these tubes to the action of carbon dioxide conditions. For this purpose we inoculated with identical amounts of the various germs two sets of milk tubes, one set remained exposed to the air, the other set was placed in Novy's anaërobic bottle into which was passed 77.7 per cent of carbon dioxide. This was allowed to stand twenty hours when plates were made from the aërobic set and at the same time from the anaërobic set. Care was taken to use the same measure for each germ under study. In the same way the second series was executed, but instead of using 77.7 per cent of carbon dioxide, 60.02 per cent was used. The result of this work will be found in the table below:—

TABLE XV.

ACTION OF CARBON DIOXIDE UPON BACTERIA WHEN CULTIVATED IN MILK.

No. of micro-organism.	I.		II.	
	No. of colonies in one measure from		No. of colonies in one measure from	
	Tube milk cultures grown in 77.7% CO_2.	Tube milk cultures grown in air as check.	Tube milk cultures grown in 60.02% CO_2.	Tube milk cultures grown in air as check.
119	256	10868	6460	34660
120	64484	2920320	28620	71550
121	34320	25430	30719	24708
122	114400	572000	25758	57240
123	10863	71500	968	7200
124	68640	143100	19461	33580
125	6840	22880	620	20460
126	1716	34320	193	3444
127	9152	102966	....	....
128	172600	257400	18889	21083
129	25	1600	....	....
130	....	....	1621	2671
131	21736	286000	17588	17935
132	2432	21736	200	5600
133	2860	6292	4160	35300
134	5720	64074	580	8160

Sterilized milk from which the carbon dioxide has been expelled may be inoculated with micro-organisms, and if exposed to the action of an atmosphere of carbon dioxide shows some retardation in the development of these micro-organisms. Furthermore, the action of the carbon dioxide upon milk cultures corresponds very closely to the action of carbon dioxide upon plate cultures. There appears to be the same retarding and, in some cases, inhibiting influences at work as had been so noticeable in the preceding tables.

XVIII. ACTION OF CARBON DIOXIDE UPON BACTERIA WHEN CULTIVATED IN BOUILLON.

The results given in the following table were obtained by taking bouillon tubes and inoculating two sets; one set was placed in the air as check and the other was placed in 88.5 per cent carbon dioxide. The methods of measurement employed were identical with those in the previous milk culture experiment.

TABLE XVI.

ACTION OF CARBON DIOXIDE UPON BACTERIA WHEN GROWN IN BOUILLON.

No. of micro-organism.	Tubes grown in 88.5% CO_2.	Tubes in air as check.
119	No growth	Dense growth.
120	*Retarded development	Dense growth.
121	No growth	Slight development.
122	Retarded development	Dense growth.
123	No growth	Dense growth.
124	Retarded development	Dense growth.
125	No growth	Dense growth.
126	No growth	Dense growth.
127	No growth	Dense growth.
128	Retarded development	Dense growth.
129	No growth	Dense growth.
130	†Slight development	Dense growth.
131	Retarded development	Dense growth.
132	Slight development	Dense growth.
133	No growth	Dense growth.
134	Slight development	Dense growth.

* Retarded development. Slightly less cloudy than air tubes.
† Slight development. Growth only perceptible.

Table XVI clearly demonstrates also that the density of development of the two sets of bouillon tubes varies, and that in some cases there is no development so far as cloudiness is any indication, while in other cases there has only been a retarding action. The results in this table agree with those obtained in plate and milk cultures. (Tables X, XII, XIII, XIV, XV.)

XIX. HOW AN ATMOSPHERE OF CARBON DIOXIDE INFLUENCES THE CHARACTER OF THE FERMENTATION OF MILK.

To pursue a study of this subject we have felt it necessary to use the so called Hesse flasks. These flasks were filled with milk which after sterilizing were inoculated. The air in the flasks above the milk was expelled by passing carbon dioxide until complete substitution had been made. Since as shown in the previous tables the action of carbon dioxide is marked by its retarding or inhibiting the growth of bacteria it is not necessary to consider it further but rather to study the peculiar influence which the gas exerts upon the character of the fermentation of milk caused by specific bacteria.

TABLE XVII.

HOW AN ATMOSPHERE OF CARBON DIOXIDE INFLUENCES MILK FERMENTATIONS.

*No. of micro-organism.	119.	120.
Culture in air	Complete peptonization with yellow pigment.	Soft curd.
Culture in CO_2	Curdled and no pigment, perhaps a very slight peptonization.	No change apparent.

No. of micro-organism.	121.	122.	123.	125.
Culture in air	Solid curd.	Solid curd.	Peptonized completely.	Peptonized completely.
Culture in CO_2	Solid curd.	No apparent change.	Curdled only.	Curdled only.

No. of micro-organism.	126.	128.	129.	130.
Culture in air	No apparent change.	Curdled.	Peptonized completely.	Peptonized completely.
Culture in CO_2	No apparent change.	Curdled.	Curdled.	No apparent change.

No. of micro-organism.	131.	132.	133.	134.
Culture in air	Solid curd.	No apparent change.	No change.	Solid curd.
Culture in CO_2	No change perceptible.	No apparent change.	No change.	No change.

*These cultures were one month old before recording results.

The general conclusion to be reached from a study of this table is the checking or total inhibition of the fermentation. In germ 119, a pigment micro-organism, the pigment has entirely failed to develop. In other cases the air check has given rise to a slight curd, whereas in the carbon dioxide flask there was no apparent change in the milk. The peptonizing germs which are capable of completely peptonizing milk when exposed to air, in the carbon dioxide flask, apparently stopped with the curdling of milk and only very slight if any peptonization. It follows therefore, that carbon dioxide may influence the character of the fermentation even when allowed to continue for one month. These differences begin to appear within twenty-four hours after inoculation and persist throughout. Yet where complete peptonization occurs in the air cultures and only curdling in the carbon dioxide cultures, it must be understood that the curdling is also an intermediate stage in the fermentation of the air cultures. At this point I desire to call the reader's attention to the comparison of Table (No. XXIV) which indicates the retarding influences or inhibiting influences of unaërated milk upon bacteria. These will be found in later discussions.

XX. ACTION OF HYDROGEN UPON THE DEVELOPMENT OF SPECIFIC MICRO-ORGANISMS.

It is pertinent to place against the previous work, the action of hydrogen upon the micro-organisms which have been studied thus far. The purpose of this is, not only to check the previous work but to indicate whether the results obtained thus far are entirely due to carbon dioxide present, or to what may be regarded as the anaërobic conditions. To speak of these conditions without defining exactly their nature must, of course, leave us somewhat in darkness, but this must always remain so until more is known concerning anaërobic life. It is a common practice to use hydrogen in securing anaërobic conditions; for this reason, a comparison of hydrogen with carbon dioxide may be of interest. The methods were the same as in the previous work. Table XVIII tabulates the results.

TABLE XVIII.

ACTION OF HYDROGEN UPON THE DEVELOPMENT OF SPECIFIC MICRO-ORGANISMS.

No. of micro-organism.	Plates developed in hydrogen.		Plates developed in air as check.	
	Growth.	No. of colonies.	Growth.	No. of colonies.
119	n. g.	....	v. g.	1,200
120	r. g.	1,500	v. g.	1,540
121	v. g.	4,592	v. g.	5,166
122	r. g.	3,200	v. g.	4,480
123	n. g.	....	v. g.	1,158
124	r. g.	6,400	v. g.	9,600
126	n. g.	....	v. g.	3,100
127	n. g.	....	v. g.	720
128	r. g.	3,900	v. g.	4,576
129	....	....	....	....
130	r. g.	1,500	v. g.	4,400
131	r. g.	1,300	v. g.	1,580
132	n. g.	....	v. g.	1,120
133	n. g.	....	v. g.	1,440
134	v. g.	1,680	v. g.	1,740

From this table there will be found a very close similarity in the results as found in the case of carbon dioxide. The differences are so slight that in a general conclusion they may be overlooked.

XXI. ACTION OF NITROGEN UPON THE SPECIFIC MICRO-ORGANISMS STUDIED.

Nitrogen in this case is considered, or the residual gas left after the absorption of oxygen from the air by the use of alkaline pyrogallate. Of the plate cultures, one set remained in the air as check and the other set was placed in a jar from which the oxygen was absorbed. The plates were made by the same methods used heretofore. The results are tabulated in Table XIX.

TABLE XIX.

No. of micro-organism.	Plates developed in nitrogen. (air-oxygen).		Plates developed in air as check.	
	Growth.	No. of colonies.	Growth.	No. of colonies.
119	v. g.	8,320	v. g.	9,600
120	v. g.	9,000	v. g.	8,400
121	....	....	....	....
122	v. g.	1,850	v. g.	1,800
123	r. g.	1,625	v. g.	1,785
124	v. g.	2,200	v. g.	2,324
126	r. g.	256	v. g.	3,840
127	n. g.	....	v. g.	1,508
128	....	....	....	....
129	....	....	....	....
130	Liquefied.	....	Liquefied.	....
131	v. g.	2,020	v. g.	1,785
132	r. g.	5,120	v. g.	5,760
133	r. g.	880	v. g.	1,560
134	v. g.	innum'ble.	v. g.	innum'ble.

Nitrogen or the residual gas resulting from the absorption of oxygen from the air does not appear to have the same detrimental effect upon these micro-organisms as either the carbon dioxide or hydrogen. We are led to believe, therefore, that the gases themselves play an important part in the restraining influences exercised when these gases are employed and the injurious effects observed may be counted as reaching beyond that which may be considered as purely anaërobic conditions. There is a retarding and inhibiting influence caused by carbon dioxide and also by hydrogen. In the case of milk, it must of course be due to carbon dioxide alone so far as the action of a gas is concerned. It is generally considered that hydrogen is not an inert gas when employed for the cultivation of anaërobic bacteria (Novy-Cent. f. Bakt. XIV 586). Liborius has shown that carbon dioxide likewise is not suitable as an atmosphere for anaërobiosis (Cent. f. Bakt. III-768). Fraenkel in the case of symptomatic anthrax bacillus and malignant edema bacillus found carbon dioxide completely checking the growth and apparently killing the bacteria (Zeit. f. Hyg. V-323).

The conclusion reached regarding nitrogen should be regarded as indicative of a wide influence exerted by gases in the production of anaërobiosis. While the prime essential to anaërobiosis is an absence of oxygen, yet there must usually be associated with this absence a substitute gas which necessarily imparts to the germ environment favorable or unfavorable factors in the determination of active cell metabolism and cell growth. It becomes therefore exceedingly difficult to definitely state the actual conditions of anaërobiosis.

Before arriving at a definite and specific notion of what is involved in the process or aëration, other factors, other than carbon dioxide have to be considered. One of these is the relation of acidity to the growth and increase of micro-organisms.

XXII. THE INFLUENCE OF LACTIC ACID AS FOUND IN WHEY OBTAINED FROM MILK OF DIFERENT DEGREES OF ACIDITY.

It is necessary after studying the influence of carbon dioxide upon the growth of micro-organisms in milk and ascertaining its probable influence and to what extent its influence may be exerted, to consider the action of lactic acid upon germ life as it is produced during the fermentation of milk. Moreover no factor which apparently has a direct bearing upon the germ-content of milk can be eliminated without a possible detriment to the conclusions about to be drawn later, consequently it is evident that this item has a very pertinent connection. It is well established that anaërobic conditions sometimes alter the acidity of cultures, primarily as the result of the functional activity of the cell influenced by the exclusion of oxygen. The important bearing of this fact will be brought out more prominently as we continue our studies.

We have sought to obtain the actual fermentation products without materially interfering with the food qualities of the milk. It is well known that as soon as the acidity increases slightly, the milk is more likely to curdle during the process of sterilization; in other words, heat favors the curdling of milk in the presence of traces of acid while the same milk in the cold shows no formation of curd. It is evident that in order to secure the fermentation products, the curd must be removed and some other nitrogenous substance added to take its place. The milk was allowed to sour for variable lengths of time after which it was heated. The curd was now removed and one per cent of peptone added. The media was then clarified and the acidity determined when they were sterilized in the ordinary manner. The media thus prepared and having different acidities were inoculated with the various micro-organisms. In this way the influence of the fermentation products could be studied.

The table below indicates by a (+) plus sign the micro-organisms having grown and the (—) minus sign the micro-organisms having failed to grow.

TABLE XX.

THE INFLUENCE OF LACTIC ACID AS FOUND IN WHEY OBTAINED FROM MILK OF DIFFERENT DEGREES OF ACIDITY.

Per cent acidity (estimated as lactic acid)	.162	.261	.306	.333	.351
No. of micro-organism.					
119	+	—	—	—	—
120	+	—	—	+	—
121	+	—	—	—	—
122	+	—	+	+	—
123	+	+	+	+	—
124	+	—	—	—	—
125	+	—	—	—	—
126	+	—	—	—	—
127	+	—	—	—	—
128	+	—	+	—	—
129	+	—	—	—	—
130	+	—	—	—	—
131	+	—	+	—	—
132	+	+	—	—	—
133	+	—	—	—	—
134	+	—	+	—	+

From the above table it will be interesting to note how some of the germs which seemed the least resistant to carbon dioxide are most resistant to the acid. No. 123 is a good illustration of this. In some of the other cases there is a correspondingly apparent inhibition due to the acid as was previously due to the carbon dioxide. Consequently some attention must be given to the direct bearing of the acidity upon the growth of micro-organisms in milk; accordingly a study of carbon dioxide in its action upon the indicator (phenolphthalein) should be made before considering the direct bearing the acidity has upon aëration, for it is very evident that the acidity of milk may be most erroneously estimated if the indicator does not satisfactorily respond. The action of carbon dioxide upon phenolphthalein is well known.

XXIII. HOW CARBON DIOXIDE MAY INCREASE THE ACIDITY OF MILK TO PHENOLPHTHALEIN.

Two Hesse flasks containing milk were sterilized, one was allowed to remain in contact with the air and the other had passed into it carbon dioxide to complete substitution. The following brief statement gives the results:

Flask of milk sterilized and exposed to air gave in acidity 16° (.144 per cent).

Same milk sterilized in Hesse flask and carbon dioxide substituted for air gave 37° (.333 per cent) acidity.

Both flasks were allowed to stand 48 hours before testing acidity, using phenolphthalein as indicator in both cases.

This study is purposely made as explanatory to what follows. Phenolphthalein is the most satisfactory indicator for measuring the acidity, yet the influence of carbon dioxide and of acid phosphates upon it should be constantly regarded in the consideration of this work, otherwise misinterpretations may follow. In the case above there has been practically an increase of over .1 per cent acidity, yet further work indicates that there is a greater difference in the amount of acidity produced in carbon dioxide cultures as compared with that produced in air cultures than can be accounted for by the influence of carbon dioxide upon the indicator.

XXIV. HOW CARBON DIOXIDE MAY INCREASE THE ACIDITY OF MILK CULTURES OF SPECIFIC MICRO-ORGANISMS.

Bearing in mind that carbon dioxide and acid phosphates may in and of themselves increase the acidity from .2 per cent to .3 per cent, yet the table which is appended indicates in many instances an advanced increase beyond this limit; in other words, the acidity is greater than that which can be accounted for by carbon dioxide alone, the acid phosphate being equal in both instances. However, care should be taken to allow in each case, at least .2 per cent for the possible increase due to carbon dioxide present in cultures. Perhaps other indicators might be found which would avoid the trouble experienced by the use of phenolphthalein, still cochineal, methyl orange, rosolic acid, and litmus were tried and the results were even more unsatisfactory. The table below in several instances will give such an increase in the acidity, that to account for it by the presence of carbon dioxide would apparently be fallacious. We have not been able to increase the acidity of milk .5 per cent simply by saturation with carbon dioxide as was done in the Hesse flasks in which the acidity was increased .189 per cent.

XXI.

HOW CARBON DIOXIDE MAY INCREASE THE ACIDITY OF MILK CULTURES OF SPECIFIC MICRO-ORGANISMS.

No. of micro-organism.	119.	120.	121.	122.	123.	124.	125.	126.
Acidity of air cultures........	.054	.18	.72	.176	.029	....	.118	.137
Acidity of CO_2 cultures................	.36	.68	1.06	.622	.529	....	.515	.436

No. of micro-organism.	127.	128.	129.	130.	131.	132.	133.	134.
Acidity of air culture..................	....	.641	.173	.094	.580	Neut.	.036	.670
Acidity of CO_2 culture..................	....	.659	.432	.486	.731	.522	.367	.720

The only conclusion that can be drawn from germs 120, 122, 123, 125, 126, 129, 130, 132 and 133 is that the acidity produced must be in part due to the conditions under which they were grown. I find this further proved by the use of hydrogen in place of carbon dioxide, although the results differ.

XXV. HOW HYDROGEN MAY ALTER THE ACIDITY OF MILK CULTURES OF SPECIFIC MICRO-ORGANISMS.

Here again we find that the acidity varies when the micro-organisms in question are grown under hydrogen but not exactly in the same way as carbon dioxide. The methods employed were identical with those used in studying the influences of carbon dioxide. The following table will indicate the influence of hydrogen:—

TABLE XXII.

HYDROGEN ANAËROBIC CONDITIONS AS COMPARED WITH AËROBIC CONDITIONS REGARDING THE ACIDITY PRODUCED.

No. of micro-organism.	119.	120.	121.	122.	123.	124.	125.	126.
Acidity of air cultures..................	.098	.518	.472	.522	.284	.796	.288	.576
Acidity of hydrogen cultures..	.085	.63	.461	.551	.292	.418	.299	.706

No. of micro-organism.	128.	129.	130.	131.	132.	133.	134.	Control.
Acidity of air cultures..................	.742	.112	.220	.680	.212	.086	....	.162
Acidity of hydrogen cultures...........	.518	.209	.310	.641	.277	.166	....	.162

XXVI. IS IT THE CARBON DIOXIDE WHICH CAUSES A CONSTANT RISE OF ACIDITY IN CONFINED MILK IN CONTRA-DISTINCTION TO MILK EXPOSED TO THE AIR?

In this test, tubes were completely filled with milk, plugged so as to exclude all air, and the stoppered ends were placed in mercury. The milk used was from a sample obtained immediately after milking. The tubes and stoppers were sterile. Some of the same sample was placed in a Fernbach flask so as to form a layer 1 cm. thick. The acidity of the milk was 16° or .144 per cent (estimated as lactic acid). The milk remained confined and also exposed for 16 hours. The summary of the work is as follows:

Milk confined for 16 hours gave 16° (.144 per cent) acidity.

Milk exposed for 16 hours gave 13.5° (.1215 per cent) acidity. (In tin vessel.)

Confined milk run drop by drop over six foot tin surface gave 14.5° (.1305 per cent) acidity, a reduction of 1.5° (.0135 per cent) in the acidity.

Confined milk brought to a brisk boil gave 14.5° (.1305 per cent) acidity, a reduction of 1.5° (.0135 per cent) in the acidity.

Here we have an indication that carbon dioxide accounts for at least 1.5° acidity, consequently a study of the acidity in confined milk without the influence of any gas has been undertaken.

XXVII. INFLUENCE OF CONFINEMENT OF MILK UPON ACIDITY.

The milk samples of these tests, the results of which are given in tabulated form, were, in each case, carried out in exactly the same manner as in the preceding experiment; that is, the milk confined and also that exposed to the air came from the same lot which was procured immediately after milking. In no instance was air allowed to remain in the tubes. If we go back and recall the gas-content of milk as found to exist immediately after milking the percentage of carbon dioxide would be about sixty. If carbon dioxide in the free state is the determining factor then there should exist corresponding results in acidity, likewise in the number of germs involved in the fermentation.

TABLE XXIII.

INFLUENCE OF CONFINEMENT OF MILK UPON THE ACIDITY.

(Numbers represent percentages calculated as lactic acid.)

TEST I.

	Confined.	Exposed over glass.	Exposed over tin.
After milking	.1125	.1125	.1125
After 21 hours	.1125	.072	.054
After 39 hours	.1305	.072	.054
After 48 hours	.1395	.035	.045
After 87 hours	.162	.0675	.195

TEST II.

	Confined.	Exposed over glass.	Exposed over tin.
After milking	.1215	.1215	.1215
After 20½ hours	.126	.09	.09
After 24 hours	.135	.09	.09
After 40 hours	.144	.117	.1385
After 48 hours	.144	.126	.225
After 64 hours	.144	.198	.315
After 69 hours	.198	.2295	.342
After 88 hours	.1755	.378	.486
After 96 hours	.1755	.423	.513

TEST III.

	Confined.	Exposed over glass.	Exposed over tin.
After milking	.135	.135	.135
After 4 hours	.162	.162	.144
After 8 hours	.1625	.144	.135
After 13 hours	.171	.144	.144
After 18 hours	.180	.180	.405
After 26 hours	.495	.4365	.531
After 34 hours	.7875	.666	.693

These tables are fairly representative of the results obtained after a great many tests. Usually the milk confined does not fall in acidity from the time when it is put up to the time when it begins to increase in acidity. Occasionally it will fall slightly. In the case of exposed milk in Fernbach flasks of glass there is a falling off in acidity for a time, then there follows a rapid increase until the milk completes its full fermentation. It is interesting also to note that in the case of a tin vessel made in the form of the Fernbach flask the falling off in acidity is much more noticeable; and usually after the acidity begins to increase, this increase is much more rapid than in the case of the glass Fernbach flask. These tables also show that usually the milk exposed to the air under the conditions given sours more rapidly than when confined; occasionally, but seldom, as in Test III, the reverse is the case. I have inserted this test as one that is somewhat rare. Tests I and II represent the usual results obtained. In connection with the acidity of milk, several problems present themselves which cast some light upon its gas-content. Unaërated milk containing 60 per cent carbon dioxide does not act the same as milk which has had 60 per cent carbon dioxide maintained over its surface and with which it was mixed. We find that milk after milking has about 60 per cent carbon dioxide which we estimate as free carbon dioxide and this will give a low estimate of acidity when phenolphthalein is used as an indicator, in fact the acidity is regarded as normal, but as soon as the free carbon dioxide is passed into the milk or the same percentage maintained over it immediately the acidity ascends rapidly. This condition may be explained by the solubility of carbon dioxide. Normal milk cannot be considered saturated with this gas. By passing carbon dioxide into the milk the acidity to phenolphthalein rises from 13° (.117 per cent) acid to 19° (.171 per cent) in ten minutes, to 28° (.252 per cent) in thirty minutes, to 38° (.342 per cent) in seventy minutes. This does not correspond in any manner to confined milk other than the fact that confined milk does not fall in acidity until fermentation sets in.

XXVIII. DO UNAËRATED CONDITIONS OF MILK TEND TO HOLD BACTERIA IN CHECK?

In these tests, three of which are recorded as representative, I have endeavored to study the germ content in milk subjected to exactly the same conditions as we found in the previous study of acidity. The same sample of milk was used in each instance and great care exercised in securing exact dilutions and measures. In each count several plates were made from each sample and the average taken.

TABLE XXIV.

DO UNAËRATED CONDITIONS OF MILK TEND TO HOLD BACTERIA IN CHECK?

TEST I.

	Confined.	Exposed over glass.	Exposed over tin.
After milking	8,400	8,400	8,400
After 21 hours	31,950	336,300	14,096,400
After 39 hours	756,000	84,292,500	125,650,500 Curdled.
After 48 hours	1,096,000	215,205,000 Curdled.	250,739,000
After 87 hours	1,747,500,000	8,142,500,000	10,037,500,000

TEST II.

	Confined.	Exposed over glass.	Exposed over tin.
After milking	6,620	6,620	6,620
After 20½ hours	31,850	46,750	331,400
After 24 hours	35,950	62,250	798,150
After 40 hours	360,000	53,282,000	914,895,000 Curdled.
After 48 hours	773,000	109,999,000 Curdled.	1,069,205,000
After 64 hours	160,000,000	877,500,000	3,722,500,000
After 69 hours	155,000,000	2,570,000,000	1,702,500,000
After 88 hours	112,500,000	1,760,000,000	1,650,000,000
After 96 hours	75,000,000	1,517,500,000	1,227,500,000

TEST III.

	Confined.	Exposed over glass.	Exposed over tin.
After milking	1,280	1,280	1,280
After 4 hours	4,650	5,120	9,400
After 8 hours	76,950	557,950	1,236,750
After 13 hours	2,779,300	15,582,000	21,036,500
After 18 hours	41,105,750	66,301,750	90,782,560 curdled.
After 26 hours	333,939,000	454,522,000 curdled.	724,632,000

In the above tables it will be very apparent that the confined conditions of milk tend to reduce the number of bacteria. Milk exposed to air far exceeds the number of germs in unexposed milk. Compare too the milk exposed over glass and the milk exposed over tin and the tin receptacle seems to favor the development of bacteria. This corresponds very closely to the previous tables in which a study of the production of acidity has been made. Why tin under these conditions favors the development of bacteria over the development of bacteria in a glass receptacle, unless the tin combines with carbon dioxide and also reduces the amount of lactic acid, is difficult to explain inasmuch as there appears to be some germicidal action instigated by bringing media in contact with metals. One factor, however, remains. In the case of tin we have a dark vessel and in the case of glass the entrance of light rays, although in a semi-dark room, may account for the reduced numbers in the glass vessel below those in the tin vessel. This hardly seems credible, however. The explanation will probably be found in the affinity of the tin surface for carbon dioxide and lactic acid.

An attempt was further made to ascertain whether by growing the plates, made from the milk in confinement, in hydrogen would increase the number of colonies developing. Several tests thus made only served in reducing the number of colonies instead of increasing them. We can understand this decrease to be due to the action of hydrogen.

XXIX. DOES AËRATION INFLUENCE THE GERMICIDAL ACTION OF MILK?

This interesting action of milk should not be passed over without showing the possible influence aëration may have upon it. The impetus given to this work by Conn and Hunziker led me to attempt to ascertain whether milk unexposed to the air would have a greater or less germicidal action than milk exposed to the air. Several tests were made, six of which are recorded below giving the results in detail. The milk was secured with the apparatus used in study of the gas-content of milk without exposure to air.

TABLE XXV.

DOES AËRATION INFLUENCE THE GERMICIDAL ACTION OF MILK?

No. of micro-organism.	I.		II.		III.	
	Aërobic.	Anaërobic.	Aërobic.	Anaërobic.	Aërobic.	Anaërobic.
After milking	2600	2600	3290	3290	3120	3120
3 hours after milking	520	680	2580	2080	1700	1440
6 hours after milking	790	730	1660	1430	1560	1310
9 hours after milking	610	850	1190	1270	1670	1210

No. of micro-organism.	IV.		V.		VI.	
	Aërobic.	Anaërobic.	Aërobic.	Anaërobic.	Aërobic.	Anaërobic.
After milking	3090	3090	12348	12348	11582	11582
3 hours after milking	620	920	8801	509	8070	10030
6 hours after milking	240	1090	3320	408	4840	9660
9 hours after milking	720	1160	3314	331	4490	4030

There is only one conclusion to be drawn from the above tests, although there are some results which do not fully accord: there is no difference existing between the germicidal action of unexposed milk and milk exposed to the air. Thus as far as the germicidal action is concerned we cannot consider that aëration favors it.

XXX. DOES AËRATION AS PRACTICED REDUCE THE NUMBER OF BACTERIA WHILE THE MILK IS FLOWING OVER THE AËRATOR?

We were not able to employ a common milk aërator for this work but resorted to the use of glass, tin and copper sheets which we used for aërating purposes when studying the action of aëration upon the gas-content. The same inclined surfaces were employed and aëration was carried out in exactly the same way. The number of germs before aëration was estimated; the milk was run over the inclined sterile surfaces of the materials mentioned and then the number of germs estimated again. In the following table will be found detailed results:—

TABLE XXVI.

DOES AËRATION AS PRACTICED REDUCE THE NUMBER OF BACTERIA SIMPLY WHILE THE MILK IS FLOWING OVER THE AËRATOR?

Date.	Jan. 3d.	Jan. 4th.	Jan. 6th.	Jan. 7th.	Jan. 8th.	Jan. 9th.
Aërating surface	Glass.	Glass.	Glass.	Tin.	Tin.	Copper.
Extent of surface	6 ft. x 1½ in.	6 ft. x 1½ in.	6 ft. x 1½ inch.	6 ft. x 1½ inch.	6 ft. x 1½ inch.	6 ft. x 1½ inch.
Amount of milk aërated	1 L per hour.	1 L per hour.	1 L per hour.	1 L per hour.	1 L per hour.	1 L per hour.
No. of bacteria in unaërated milk	*2860	3630	8410	2810	3100	2750
No. of bacteria in aërated milk	2750	3710	9590	2600	3310	3800

*The number of bacteria found in 1 c. cm.

If this method of aëration can be regarded as one simulating the methods in vogue we are forced to conclude that the simple act of aëration does not reduce the number of micro-organisms in the milk and that if any reduction occurs it must be due to some indirect action which aëration must have upon the milk.

XXXI. SUMMARY.

I. Milk drawn from the udder of a cow contains a high percentage of carbon dioxide and a low percentage of oxygen. The gas pumped from milk contains on an average 81.49⅔% of carbon dioxide and 2.42% of oxygen.

II. During the milking process the percentage of carbon dioxide contained in the pumped gases from milk dropped to an average of 59.63⅔% and the oxygen increased to an average of 13.17⅔%.

III. During aëration the carbon dioxide of the pumped gases dropped still farther to an average of 40.57 1-6% over glass, 35.832% over tin, 42.328% over copper, and to 25.805% through glass wool; the oxygen increased to an average of 20.586% over glass, 20.55% over tin, 17.256% over copper and through glass wool to 20.805%.

IV. Air confined over sterilized milk indicates no interchange of gases.

V. Most micro-organisms in milk generate carbon dioxide and absorb oxygen.

VI. Milk fresh from the cow and confined in a flask consumes the oxygen and liberates carbon dioxide upon fermentation.

VII. When antiseptics are used in fresh milk, oxygen is very slowly absorbed and no appreciable quantities of carbon dioxide are given off.

VIII. Free carbon dioxide in amounts of 100%, 96.5%, and 62.9% have a marked restraining action on bacteria and in some cases an inhibitive action.

IX. A percentage of 32.9% of carbon dioxide stands on a border line where the action of this gas gradually disappears.

X. When free carbon dioxide is made to act upon sterilized and inoculated milk the restraining influence is also very noticeable.

XI. When bacteria are grown in bouillon under the influence of carbon dioxide, this restraining action is very prominent.

XII. Free carbon dioxide has a direct influence upon the character and rate of milk fermentations induced by specific micro-organisms.

XIII. Carbon dioxide in its free condition corresponds very closely in its action upon bacteria with carbon dioxide as it exists in milk, and it constitutes about the same percentage of the pumped gases.

XIV. Hydrogen has practically the same action on bacteria as carbon dioxide.

XV. The nitrogen or residual gas resulting from the absorption of oxygen from air by means of alkaline pyrogallate is not so detrimental to the development of bacteria as free carbon dioxide or hydrogen.

XVI. Lactic acid has a varying influence upon the development of different micro-organisms.

XVII. The acidity of milk is influenced by the aërobic and anaërobic conditions under which micro-organisms are cultivated.

XVIII. Confined milk does not show a decrease in acidity after milking.

XIX. Milk exposed freely to the air decreases in acidity for a few hours after milking then the acidity rises rapidly.

XX. Carbon dioxide is one factor which keeps up the acidity of confined milk with phenolphthalein as an indicator.

XXI. Bacteria do not thrive so well in unaërated milk without exposure as in exposed milk.

XXII. The germicidal action of milk is not influenced by the aërobic or anaërobic conditions.

XXIII. The aëration of milk does not reduce the number of bacteria directly.

A review of the summary immediately brings before us striking evidence that underlying aëration of milk are to be found indisputable data fundamentally important which may lead us to definite conclusions. In the determination of the gas-content of milk, the rapid decrease of carbon dioxide and the increase of oxygen content at once demonstrates that there is a considerable change in the gases of milk through aëration. There is to be no sanitary significance attached to this interchange of gases per se, but the fact that such a striking change is taking place is of sufficient weight to assist in the solution of pertinent problems.

We have not positively shown that these gases which have been subjected to study are in loose combination or free but since the carbon dioxide runs down rapidly to a certain percentage where its liberation from the milk becomes quite difficult and since the percentage of oxygen may be increased above the content of air, there does seem to be some evidence favoring the idea that there is a combination rather than the existence of the gases in the free condition, yet small amounts of carbon dioxide are with difficulty removed from distilled water and when such salts as sodium carbonate, sodium hydrogen phosphate et cetera are in solution this difficulty is greatly increased. Furthermore, when an attempt is made to simulate the effects of carbon dioxide in milk by the use of free carbon dioxide there exists a marked similarity so far as the growth of the germs is concerned, but just as soon as we begin to study the acid effects upon the indicator we find that the carbon dioxide which we obtain does not act the same as the carbon dioxide as we add it in the free state. However, it should be remembered that the solubility of carbon dioxide in water is practically 100 per cent while the most obtained from milk is not above 10 per cent by volume. It would be unsafe, therefore, to draw a positive conclusion from the facts we have regarding the condition of carbon dioxide in milk or the condition of oxygen; our knowledge must remain as it is. The weight of evidence does not favor an apparently loose combination, because it may be accounted for by the solubility of the gas, and thus must at first follow a rapid reduction of carbon dioxide in the milk when exposed in an effort to establish an equilibrium.

The increase of oxygen during the milking process also must have considerable influence upon our judgment relative to the common methods of handling milk in the stable. If carbon dioxide is eliminated so rapidly and oxygen increases, there must of course be a rapid interchange of gases going on during the milking process while the milk is more or less agitated by the passage of the streams of milk from the teats of the cow to the surface of the milk in the pail, and to the impinging of the streams against the surface of the milk in the pail causing a churning effect. Now if this interchange takes place as is indicated by the analyses over and over again, it follows that if any obnoxious gases exist in the stable they must necessarily invade the milk as does the oxygen; by this means the milk is rendered unwholesome to a greater or less degree by the gases existing in the stable. Should the operations which are commonly in vogue at the present time be carried out and the milk disturbed by pouring it through a strainer into a milk can or even over an aërator or cooler in the stable air it is easy to understand how the gases of the milk and the gases of the air find an equilibrium. This of course means that the gases in the milk and the gases of the air must substitute each other to a great extent. The practice of milking in filthy stables containing filthy odors is therefore reprehensible.

There may be an elimination of taints which originated by means of physiological processes in the cow or emanate from bacterial fermentation processes. It has been an old and common belief and is still that animal odors and taints are to a large extent removed by aëration. This is evidently true. In our experience we have so removed the animal odor from the milk that no odors were perceptible even when warmed. Knowing that the gas-content of milk and the air gases interchange freely when milk is agitated or spread out in a very thin film the explanation of this removal of animal odors and taints appeals to our understanding, and very naturally, in the light of preceding studies. However, the methods employed for aëration must be effective to accomplish satisfactory results.

The interchange of gases going on in a closed can of milk over which is a small air space as is usually the case should be looked upon as resulting from fermentation processes rather than from physical or chemical interchange of gases. Blyth has satisfactorily shown that milk undergoing fermentation soon reaches the point where oxygen completely disappears and carbon dioxide is practically the only gas present. In connection with antiseptics in fresh milk where all fermentation has been arrested it is true the oxygen greatly diminishes in amount, but it requires some time to bring about a marked diminution of this gas, consequently the interchange of gases is due to a slow oxidation process such as is well known to exist in a great many complex organic compounds; what oxygen may be present in the milk itself may be utilized by numerous possible bacterial changes. It is apparently true that if milk remains quiet that the oxidation which takes place through contact with the oxygen in the milk is probably as slow as is known to be the case where oxygen permeates agar or gelatine and influences the life zones of the media. We should not expect that where milk is standing quiet that the oxygen diminution would be very noticeable for several hours even though fermentation be held in check. The production of carbon dioxide in large amounts by bacteria, the absorption of oxygen or the consumption of oxygen by bacteria have long been known.

Carbon dioxide does not exert any effect upon the germicidal action of fresh milk, since it is found that the germicidal action of milk confined without exposure to the air and that which is exposed to the air are practically the same; that is, the ratio of reduction of the number of germs does not differ in the two cases sufficiently to warrant us in drawing any other conclusion.

When the number of bacteria is estimated before and after the aëration of milk there is no appreciable reduction. consequently, we cannot look upon aëration as directly influencing the number of bacteria.

It is true that in confined milk germs do not increase as rapidly as in exposed milk but this simply supports the idea that the carbon dioxide or other anaërobic factors exert some influence over the development and increase of bacteria. Without entering into a demonstration of whether the confined conditions or anaërobic conditions of milk are likely to give rise to obnoxious fermentations we have regarded it more feasible to consider only the well established facts already known regarding aërobic and anaërobic conditions as suited to the productions of proper fermentations. Under aërobic conditions usually harmless fermentations take place; that is, fermentations confined to the ternary compounds consisting simply of carbon, hydrogen and oxygen occur, and in the destruction of these ternary compounds as is effected through these fermentations, oxygen must be present in sufficient quantities to yield the desired results. This is not always true, however, but may be regarded as generally true. Of milk fermentations, the ordinary lactic acid fermentation, the fermentation sought, is accelerated by the presence of oxygen, and if such fermentative processes may be facilitated by its action, it follows that harmful fermentations which are capable of development may be held in check. Usually where toxic or harmful effects are obtained the nitrogen molecule is acted upon and broken down. During this destruction toxic substances are formed thus producing the poisonous symptoms when the food is consumed. If a review is made of the various cases of poisoning from food, the greater number will be found to result from anaërobic or partially anaërobic nitrogenous decompositions. Brieger has shown that a trace of oxygen is necessary to the production of poisonous ptomains, but where there is a bountiful supply of oxygen no toxic ptomains are produced. Now, if it is true that the ternary compounds may be decomposed more readily in the presence of oxygen and that by this process the decomposition of the proteids may be held in check the value of substituting oxygen for carbon dioxide is plain. In the case of milk, lactic acid is depended upon to hold in check other fermentations. Repeating, lactic acid fermentation is facilitated by the presence of oxygen, consequently an actual supply of oxygen is required to control the possible detrimental fermentations. Should the milk be practically free from bacteria the need for this control is not so apparently great as where considerable filth has entered the milk, making the possible number of harmful fermentations much greater.

CONCLUSIONS.

1. Milk undergoes aëration when exposed to air from the time it leaves the milk-duct of the cow until it is consumed or made into milk-products.
2. This aëration is demonstrated by the reduction in the amount of carbon dioxide and the increase in the amount of oxygen.
3. It has been shown that aërating methods which increase the surface of the milk exposed, facilitate aëration greatly.
4. Below a certain per cent the elimination of carbon dioxide becomes very difficult.
5. By this interchange of gases between air and milk, there is a great opportunity offered for the absorption of noxious gases by the milk, unless the interchange takes place in absolutely pure air.
6. Agitation of milk favors the interchange of gases, because of the increased surface exposure.
7. Odors and taints resulting from aromatic foods, physiological processes, and disease processes may be greatly reduced permanently.
8. Odors and taints resulting from bacterial fermentations may be greatly reduced. but they will return upon the further development of bacteria.

9. The oxidation of milk is a slow process in the presence of antiseptics.

10. Where the oxygen disappears rapidly and carbon dioxide is formed in a confined air space over milk, this change is evidently due to bacterial activities.

11. Closing milk cans from the air consequently reduces the amount of oxygen supply, therefore must change the conditions of germ-life.

12. Aëration does not change the germicidal action of milk.

13. Aëration does not reduce the number of bacteria.

14. Directly confined milk does not ferment more readily than aërated milk.

15. Aëration does influence the amount of oxygen supply to the bacteria present.

16. Mere traces of oxygen favors the development of toxic products by bacteria (Brieger).

17. A plentiful supply of oxygen causes bacteria to produce non-toxic substances (Brieger).

18. The fermentations of milk are therefore influenced by aëration, favoring the production of non-toxic substances.

In closing this article it is a great pleasure to state that I have had the privilege of freely consulting Prof. F. G. Novy as this work has progressed. I am also grateful to Prof. M. Gomberg for many valuable suggestions, and to Mr. Alfred White for his useful hints in gas analysis.

ANALYSIS OF COMMERCIAL FERTILIZERS.

R. C. KEDZIE.

Bulletin 202—Chemical Department.

THE LAW.

The law providing for the inspection of commercial fertilizers and to regulate their sale in this State was enacted in 1885. The law has been reprinted in these Bulletins several times, but as there are so many new dealers and consumers who want to know the exact words of the law, it is again printed for the information of the public.

[*Act No. 26 of the Session Laws of 1885.*]

The People of the State of Michigan enact:

Section 1. Any person or persons who shall sell or offer for sale in this State any commercial fertilizer, the retail price of which exceeds ten dollars per ton, shall affix on the outside of every package containing such fertilizer a plainly printed certificate, stating the number of net pounds therein; the name or trade mark under which such article is sold; the name of the manufacturer; the place of manufacture, and a chemical analysis, stating the percentage of nitrogen in an available form; of potash soluble in water and of phosphoric acid in available form (soluble or reverted) and the insoluble phosphoric acid.

Sec. 2. Before any commercial fertilizer is sold or offered for sale, the manufacturer, importer or party who causes it to be sold or offered for sale within this State, shall file with the secretary of the State Board of Agriculture a certified copy of the analysis and certificate referred to in section one, and shall also deposit with said secretary a sealed glass jar containing not less than two pounds of such fertilizer, with an affidavit that it is a fair sample of the article thus to be sold or offered for sale.

Sec. 3. The manufacturer, importer, or agent for any commercial fertilizer, the retail price of which exceeds ten dollars per ton as aforesaid, shall pay annually to the secretary of the State Board of Agriculture, on or before the first day of May, a license fee of twenty dollars for each and every brand of fertilizer he offers for sale in this State: Provided, That whenever the manufacturer or importer shall have paid this license fee his agents shall not be required to do so.

Sec. 4. All such analyses of commercial fertilizers required by this act shall be made under the direction of the State Board of Agriculture and paid out of the funds arising from the license fees provided for in section three. At least one analysis of each fertilizer shall be made annually.

Sec. 5. The Secretary of the State Board of Agriculture shall publish in his annual report a correct statement of all analyses made and certificates filed in his office together with a statement of all moneys received for license fees, and expended for analysis. Any surplus from license fees remaining on hand at the close of the fiscal year shall be placed to the credit of the experimental fund of said board.

Sec. 6. Any person or persons who shall sell or offer for sale any commercial fertilizer in this State without first complying with the provisions of sections one, two and three of this act, or who shall attach or cause to be attached to any such package or fertilizer an analysis stating that it contains a larger percentage of any one or more of the constituents or ingredients named in section one of this act than it really does contain shall, upon conviction thereof, be fined not less than one hundred dollars for the first offense, and not less than three hundred dollars for every subsequent offense, and the offender shall also be liable for damages sustained by the purchaser of such fertilizer on account of such misrepresentation.

Sec. 7. The State Board of Agriculture by any duly authorized agent is hereby authorized to select from any package of commercial fertilizer exposed for sale in this

State, a quantity, not exceeding two pounds, for a sample, such sample to be used for the purposes of an official analysis and for comparison with the certificate filed with the secretary of the State Board of Agriculture and with the certificate affixed to the package on sale.

Sec. 8. All suits for the recovery of fines under the provisions of this act shall be brought under the direction of the State Board of Agriculture.

Approved March 10, 1885.

OBJECT OF INSPECTION OF COMMERCIAL FERTILIZERS.

There are several objects to be secured by this law and by publishing the results of inspection and chemical analyses.

1. It gives the manufacturers opportunity to place before the public the names and amounts of the materials they claim as making their several fertilizers.
2. It enables the consumer to compare the amount of fertilizing material as claimed with that actually found in the fertilizers offered for sale in the public market.
3. Where a farmer or fruit grower wants to use a fertilizer of certain composition, by consulting the Bulletin he may find the one that approaches nearest his desire.
4. It gives honorable position and recognition to the honest manufacturer and exposes the tricky dealer. It is manifestly in the interest of honest dealers and of consumers of every class to sustain a law for the protection of all parties.

The law does not prescribe any standard for the composition of a commercial fertilizer, the manufacturer being free to make his own standard, the law simply requiring that the fertilizers offered for sale shall be up to the standard set by the manufacturer. The license to sell does not certify to the value of the fertilizer, but simply states that the manufacturer or dealer offers for sale a fertilizer for which a certain content of nitrogen, potash and phosphoric acid is claimed, and that samples of such fertilizers have been deposited with the secretary of the college with affidavit regarding the composition. Analysis is then made of each of these fertilizers, gathered in the open market as far as possible, and the results of such analysis published in bulletin. The *claimed* composition and *found* composition are arranged in parallel lines, so that the real composition can be compared at a glance with the composition claimed for it by the manufacturer. In this way the buyer can see at once by this bulletin whether the fertilizer is as good as the claims made for it. The materials to be determined in such analysis are "nitrogen in available form, potash soluble in water, phosphoric acid in available form, and the insoluble phosphoric acid." The chemists of Europe and America have selected these same materials as determining the chief value of commercial fertilizers, and in every state of our union where the law prescribes chemical analysis of commercial manures as one condition of sale, these are the materials to be determined as the basis of value.

These are not the only materials concerned in raising crops, *but they are the only materials for which the farmer can afford to pay more than ten dollars a ton.*

LEADING KINDS OF FERTILIZERS.

The leading kinds of fertilizers may be classified as follows:

1. Complete Manure, which contains nitrogen in some combination, such as a salt of ammonia, nitrate of soda, or organic nitrogen; potash, as muriate or sulphate (German Stassfurth salts) or wood ashes; and phosphoric acid as a phosphate of lime. It is called a complete manure because it contains all of the three materials most essential for plant growth, and most likely to be deficient in a field after long cropping.
2. Plain Phosphate, which may be in the form of superphosphate, soluble in water or solution of citrate of ammonia, these being called available, because they are readily taken up by the roots of plants; and ground phosphate rock, an insoluble form. The bone phosphate and rock phosphate are changed into superphosphate by the action of sulphuric acid, removing a part of the lime, as sulphate.

The soluble phosphate is especially beneficial to plants in the early state of their growth, giving them a good start. In later stages of growth when the plant by its roots can forage for food in the soil, the insoluble phosphate may have nearly as beneficial an effect.

Phosphates promote the formation of flower and fruit and secure earlier ripening. They may wisely be used on vines and succulent fruits that are liable to be cut by early frosts in autumn, securing early crops with better prices and avoiding the loss of the entire crop by untimely frosts before the most of the crop had ripened. Fruit trees sometimes blossom year after year without producing fruit. This is often caused by storms at the period of flowering, but it may be caused by constitutional weakness, in consequence of which pollen of vital power is not formed. In such cases the use of active phosphates is worthy of trial.

3. Bone Meal contains phosphate of lime and animal matter rich in nitrogen and hence is very valuable for manure where we desire a prolonged influence. It is well adapted to grass lands and lawns, and is free from the bad odor often given off by mixed fertilizers. Moist meadows are benefited by a dressing of bone meal. If the bones that now adorn the back yard and pasture lot should be ground into a powder and scattered on a crop-worn field, the results would surprise some farmers.

4. Potash Manure. The best and cheapest is that neglected home product—wood ashes. These contain an average of five per cent of potash, besides a sensible amount of phosphate, and a very large amount of carbonates of lime and magnesia; they are an all-round plant manure so far as mineral matter is concerned, supplying each ash element.

Unless the farmer can bring into active form the great store of potash in his soil, he will then have to buy the German potash salts, the muriate or sulphate. These salts are yearly coming into greater prominence as potash fertilizers, but their sale in Michigan in separate form has not been large.

The influence of potash on plant life is masterful; no plant can grow without it, and its influence in developing the carbohydrates, and maturing fruits, is marked and apparently controlling.

5. Nitrogen Compounds. Nitrogen is the bottled wine of the vegetable feast. If the term stimulant can be applied to any organization destitute of a nervous system, then nitrogen is the stimulant of plant life. In any of its combined forms it gives depth of color and exuberance of growth to vegetable life, and when in abundant supply it causes the plants to break forth into riotous growth. The great reservoir of nitrogen is the air, but the leaves of plants though constantly bathed in nitrogen, cannot drink in a particle. It is only *nitrogen in combination* that can be appropriated by the plant, and this enters the plant by the roots and comes from the soil. A small amount is brought to the soil by the rain, washing out the ammonia and nitrates of the air, but the amount is not large and entirely inadequate to supply a crop.

A large amount of active nitrogen in the form of nitrates is yearly formed in every well cultivated field, and this is the cheapest way of securing a supply of this costliest element of plant growth. The raising of leguminous crops, like the clovers, is the next cheapest way of securing a supply.

Combined nitrogen is purchased in three forms: salts of ammonia, nitrate of soda, and organic nitrogen in the form of dried blood, fish scraps, cotton seed meal, etc.

6. Tankage, is a complex and variable material obtained from the waste residues at the slaughter houses, the garbage collected by the scavengers in cities, etc. These materials are dried, the grease extracted in tanks and this tankage by itself, or mixed with phosphates, potash, etc., is sold as a fertilizer. It is mainly used to give bulk to the concentrated fertilizers made from bone and rock phosphate.

SCHEDULE OF COMMERCIAL PRICES.

The following prices per pound for fertilizing materials may be used in estimating the commercial value:

Nitrogen in nitrates	$0 13
Nitrogen in ammonia salts	14
Organic nitrogen in meat, blood, etc	14
Organic nitrogen in fine bone and tankage	13½
Organic nitrogen in medium bone and tankage	10
Organic nitrogen in coarse bone and tankage	8
Phosphoric acid, available	4½
Phosphoric acid, insoluble, in fine bone and tankage	4
Phosphoric acid, insoluble, medium bone and tankage	3½
Potash as muriate	4½
Potash as sulphate and in wood ashes	5

COMMERCIAL VALUE AND AGRICULTURAL VALUE.

The commercial value and the agricultural value are not identical. The commercial value merely represents the cost of the material to make the fertilizer, if any one should attempt to make his own. The agricultural value or the benefit from the use of such fertilizer will depend upon a variety of conditions, such as the kind of soil, the crop, the season, the tillage, time of application, etc., etc. Let no one suppose that the estimate of the commercial value is a guarantee of a corresponding profit by its use on the farm. It may serve, however, as a basis of comparison between different brands of fertilizers. The reliable test of the value is determined by its use on a given soil and crop—worth more than all theoretical discussions and deductions. Yet there are certain general considerations which go to show the probable benefit of any fertilizing element when used on a certain kind of soil and crop, which will be of some benefit in selecting a fertilizer.

SELECTING SPECIMENS OF FERTILIZERS FOR ANALYSIS FOR THE BULLETIN.

The law requires the manufacturer or dealer to deposit a specimen of each fertilizer with the secretary of the Board, but such specimens are never used for analysis unless it is impossible to obtain specimens from the material exposed for sale in the open market. The object is to deal with the same material that the farmer buys for himself. In this way any collusion by which a richer fertilizer is analyzed than will be found in the fertilizer offered for sale in the open market, is prevented.

As the fertilizers arrive at somewhat uncertain periods and are distributed over a wide extent of territory, the gathering of the specimens requires much travel and time in order to cover the whole area of fertilizer consumption.

The following stations and names of the dealers give some idea of the thoroughness with which this work is done. It is not feasible to visit every dealer, but the aim is to go over the more important districts for the specimens.

Some of the parties visited on the fertilizer collection from May 6 to June 15. Names of individuals and firms, arranged in alphabetical order with reference to counties.

Bay County.
- Bay City.
  - Mosher Hardware Co.
  - Rechlin Hardware Co.
  - McDonald Hardware Co.
  - Jennison Hardware Co.
  - F. C. Goddene.
  - Boutelle Bros.
  - Presley and Layer.
  - R. C. Bialy.
  - Mitchell and Co.
  - W. H. Fay.

- *Berrien County.*
  - Benton Harbor.
    - Stephen and Morton.
  - St. Joseph.
    - Frank N. McOmber.
  - Niles.
    - John A. Montague.
    - F. Stockweather and Co.
- *Branch County.*
  - Coldwater.
    - S. I. Treat and Son.
    - Keer Bros.
    - A. Conover.
    - Reed and Johnson.
  - Quincy.
    - Michael and Spaulding.
    - I. L. Bishop.
    - Bowen and Etheridge.
- *Calhoun County.*
  - Battle Creek.
    - W. N. Dibble.
    - Rupert and Morgan.
    - W. A. Wattles.
    - V. C. Wattles.
    - Rathbun and Kraft.
  - Homer.
    - F. E. Strong Bros.
    - Snyder and Tillotson.
- *Cass County.*
  - Cassopolis.
    - J. F. Hayden.
    - McNabs Stock Farm.
  - Dowagiac.
    - Vrooman and Sons.
- *Genesee County.*
  - Flushing.
    - C. Phelps.
    - D. B. French.
    - Ottaway and Co.
  - Brent Creek.
    - C. E. Halleck.
    - G. L. Clapp.
  - Flint.
    - Pomeroy and Partridge.
    - Countryman and McNiel.
    - Smith Carriage and Harness Co.
    - Godes and Thorn.
    - Algo and Miller.
    - Edward Bros.
    - Footes and Church.
    - S. J. Hall and Co.
    - R. Putnam and Co.
  - Goodrich.
    - George Liscom.
    - Philip Hiegel.
  - Grand Blanc.
    - J. D. Banker.
    - Grant Cheeney.
    - W. C. Dewey.
    - Stewart and Son.

Hillsdale County.
- Hillsdale.
  - S. J. Shank.
  - G. N. Smith.
  - C. F. Gardiner.
  - E. H. Cunningham.
- Reading.
  - S. B. Mallery.
  - W. M. Cahow.
  - Burlingame and Browning.
  - Bartholomew and Cane.

Huron County.
- Bad Axe.
  - J. G. Wright.
  - Lamkin Dundas.
  - W. H. Carey.
  - A. T. McDonald.
- Ubly.
  - John Coppe.
  - D. H. Pierce and Sons.
  - Thomas Richardson.

Jackson County.
- Jackson.
  - Empire Drill Co.
  - James Boland.
  - S. M. Isbell.
  - E. J. Sheap and Co.
  - Reed Implement and Seed Co.

Kalamazoo County.
- Kalamazoo.
  - Kalamazoo Beet Sugar Co.
  - Ashton, Buckhout and Ashton.
  - A. F. Woodham Coal Co.
- Schoolcraft.
  - Malachi Cox.

Kent County.
- Grand Rapids.
  - Perkins and Hess.
  - Jones Seed Co.
  - Grand Rapids Glue Co.
- Sparta.
  - Sparta Milling Co.

Lapeer County.
- Almont.
  - A. T. Mair.
  - H. J. Willet.
  - R. E. Lee.
  - Hart and Sullivan.
- Imlay City.
  - Henry Lengemann.
  - J Green.
  - C. E. Donneen.
- Lapeer.
  - S. T. Gray.
  - Lapeer Hardware Co.
  - Bennet and Stickney.
  - G. W. Crampton.
  - Boston and Gass.
  - J. A. Porter.
  - Lapeer Mercantile Co.

Lenawee County.
- Blissfield.
  - J. E. Rouget.
  - J. H. Miller.
- Deerfield.
  - Frank Timmins.

Macomb County.
- Mt. Clemens.
  - Allen Houghten.
- Lenox.
  - Farmers Elevator Co.
  - Richmond Elevator Co.
  - Patterson and Lovejoy.
  - John McMann.
- Armada.
  - S. I. Stump.
  - L. D. Anderson.
- Utica.
  - Henry St. John.
  - Louis Stead.
- Waldenburg.
  - Emil O. Rose.

Monroe County.
- Dundee.
  - A. B. Hutchins.
  - W. S. Wells.
  - Frank Miller.
- Maybee.
  - Mr. Mack.
- Petersburg.
  - Charles Van Fleet.
  - C. J. Cilley.
  - D. W. Smith.
  - E. W. Sperry.
  - A. L. Briggs.
- Monroe.
  - Sieb and Baier.
  - William Steiner.
  - George F. Tinzel.
  - G. R. Hurd Sons Co.
  - Gekle and Martin.
  - J. Wahl.
- Ida.
  - Weipert and Cousino.
  - John Martin.
  - Shaffer Bros.
- Strassburg.
  - C. B. Ran.
  - Weipert and Meyer.
  - Mr. Woelmer.
- Scofield.
  - J. L. Wright.

Muskegon County.
- Muskegon.
  - August Schneidt, Jr.
  - John Albers.
  - L. H. Kanitz.

Oakland County.
- Birmingham.
  - J. R. Blakslee.
  - E. R. Smith & Co.
  - W. J. McClellan.
  - Chas. Chlaack and Co.
  - Wm. Hunt.
- Farmington.
  - W. H. Lee.
  - J. W. Halton.
  - Herman Fuss.
- Pontiac.
  - R. T. Knight.
  - F. J. Stewart and Co.
  - A. A. Convin.
  - Milles Bros.
- Royal Oak.
  - Jacob Erb.
  - J. M. Lawson.
- Rochester.
  - H. J. Taylor.
  - F. H. Burr.
  - P. J. Obrian.
  - E. S. Letts.
- Holly.
  - McLaughlin Bros. and Co.
  - Hudson's Coal and Wood Yard.
  - T. P. Morgan.
  - S. E. Trott.
- So. Lyons.
  - John Challis.

Ottawa County.
- Grand Haven.
  - Speidel and Schwartz.
  - James Lock.
- Holland.
  - T. Keppler's Sons.
  - John Nies Hardware Co.
- Zeeland.
  - Henry De Kruif.
  - B. J. Albers.
  - Isaac Van Dyke and Co.

Saginaw County.
- Saginaw.
  - C. L. Roeser.
  - Stewart Mercantile Co.
  - Saginaw Hardware Co.
  - J. P. Derby.
  - Saginaw Feed Co.
  - C. W. Bruske.
  - Popp and Wolfe.
  - Walz Hardware Co.
  - Green Bros.

St. Clair County.
- Capac.
  - H. P. Stoughton.
  - Codding and Co.
  - H. C. Seigel.

St. Clair County—Continued:
- Emmett.
  - James Cogley and Son.
  - Richmond Elevator Co.
- Smith.
  - S. J. Cochrane.
- Port Huron.
  - C. H. Kimball.
  - B. B. Hyde.
  - C. B. Waterloo.
  - M. D. Baldwin.
- St. Clair.
  - Theodore Ruff.
  - Geo. Solis.
  - E. C. Recor and Son.
  - W. R. Kemp.

Sanilac County.
- Brown City.
  - McNaughton and McCarty.
  - Geo. Winsor.
  - Shearsmith Hardware Co.
  - S. P. Powell.
  - Hardorn and Reeves.
  - Wm. Brown.
  - D. H. Brooks.
- Croswell.
  - S. D. Kinsey.
  - Smyth and Straffan.
  - Chas. McGannes.
  - D. Quail and Son.
  - Fred Farley.
  - Rice and Allen.

Shiawassee County.
- Owosso.
  - Hartshorn and Son.
  - Owosso Hardware Co.
  - Brooks and Son.
  - Ira G. Curry.
  - J. Thompson.

Tuscola County.
- Caro.
  - Myron Darby.
  - Kelsey and Co.
  - Caro Sugar Co.
  - T. W. Van Tine.
- Fair Grove.
  - Richard Elevator Co.

Washtenaw County.
- Chelsea.
  - John Walters.
  - Arthur Chapman.
  - H. Spaulding.
  - Nat Jensen.
  - N. Glowery.
  - Chas. Hashley.
  - R. Boynton.
  - Joe Myer.
  - Geo. Davis.
- Manchester.
  - Loner and Hoffer.
  - Wurster Bros. and Co.

Washtenaw County—Continued:
- Milan.
  - W. H. Hack.
  - H. L. Stewart.
  - Wm. Reeves.
  - F. G. Hasley.
- Saline.
  - A. Horning.

Wayne County.
- Detroit.
  - T. Feldman and Sons, 902 Gratiot Ave.
- Dearborn.
  - J. D. Wallace.
  - D. P. Lapham.
  - Theodore Neuendorf.
- Inkster.
  - M. V. Fisher and Co.
- Plymouth.
  - J. D. McLaren and Co.
- Wayne.
  - A. B. Wallace.
  - J. C. Cozadd.
  - Wm. Green.
- Romulus.
  - Chas. Foss.
  - W. S. McBride.

Results of analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Armour & Co., Chicago, Ill	Acidulated Bone Meal	Geo. B. Mechem, Fennville
Armour & Co., Chicago, Ill	All Soluble	Mohr Hardware Co., West Bay City
Armour & Co., Chicago, Ill	Ammoniated Bone with Potash	Manufacturer
Armour & Co., Chicago, Ill	Bone, Blood and Potash	Mohr Hardware Co., West Bay City
Armour & Co., Chicago, Ill	Bone Meal	Jones Seed Co., Grand Rapids.
Armour & Co., Chicago, Ill	Fruit and Root Crop Special	E. Farrand, Pontiac
Armour & Co., Chicago, Ill	Grain Grower	J. F. Hayden, Cassopolis
Armour & Co., Chicago, Ill	High Grade Potato	Sparta Milling Co., Sparta
Armour & Co., Chicago, Ill	Phosphate and Potash	Mohr Hardware Co., West Bay City
Armour & Co., Chicago, Ill	Star Phosphate	Manufacturer
Armour & Co., Chicago, Ill	Sugar Beet Special	Mohr Hardware Co., West Bay City
Armour & Co., Chicago, Ill	Wheat, Corn and Oats Special.	Mohr Hardware Co., West Bay City
Armour & Co., Chicago, Ill	Kankakee Valley Sugar Beet Special	Manufacturer
The American Agricultu'l Chemical Co., New York City	Bradley's Alkaline Bone with Potash	Manufacturer
The American Agricultu'l Chemical Co., New York City	Bradley's B. D. Sea Fowl Guano	J. E. Rouget, Blissfield
The American Agricultu'l Chemical Co., New York City	Bradley's Dissolved Bone with Potash	J. E. Rouget, Blissfield
The American Agricultu'l Chemical Co., New York City	Bradley's Niagara Phosphate	Wm. Hunt, Birmingham
The American Agricultu'l Chemical Co., New York City	Bradley's Soluble Dissolved Bone	Manufacturer

for 1902, expressed in parts in a hundred.

	Available nitrogen, estimated as ammonia.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
		Available.	Insoluble.	Total.	
Claimed	1.99 to 3	11 to 14	7 to 10	18 to 24	....
Found	3.20	14.08	5.88	19.96	....
Claimed	3.50 to 4.49	8 to 10	2 to 4	10 to 14	4 to 5
Found	3.40	10.56	2.14	12.70	6.44
Claimed	3 to 3.99	6 to 8	2 to 4	8 to 12	2 to 3
Found	3.30	7.02	.70	7.72	2 97
Claimed	4.99 to 6	8 to 10	3 to 4	10 to 14	7 to 8
Found	4.23	11.97	1.04	13.01	4.25
Claimed	3 to 3.99	10 to 14	14 to 16	24 to 30	....
Found	4.42	13.84	8.68	22.50	....
Claimed	2 to 2.99	8 to 10	2 to 4	10 to 14	5 to 6
Found	2.18	11.10	3.10	14.20	4.65
Claimed	2 to 3	8 to 10	2 to 4	10 to 14	2 to 3
Found	2.06	9.25	.65	9.90	2.42
Claimed	1.99 to 3	8 to 10	2 to 4	10 to 14	10 to 12
Found	1.99	8.64	.78	9.42	8.81
Claimed	....	10 to 12	2 to 4	12 to 16	2 to 3
Found	....	9.89	.28	10.17	2.11
Claimed	....	14 to 16	2 to 4	16 to 20	....
Found	....	15.82	.70	16.52	....
Claimed	1 to 2	8 to 10	2 to 4	10 to 14	4 to 5
Found	.88	7.82	1.70	9.52	4.20
Claimed	1 to 2	7 to 9	2 to 4	9 to 13	1 to 2
Found	1.05	6.34	1.22	7.56	1.
Claimed	1 to 2	6 to 8	2 to 4	8 to 12	8 to 10
Found	1.38	6.54	.52	7.06	8.17
Claimed	....	11 to 13	1 to 2	12 to 15	2 to 3
Found	....	9.98	.84	10.82	2.23
Claimed	2½ to 3½	8 to 10	2 to 3	10 to 13	1½ to 2½
Found	2.58	8.27	.76	9.03	1.69
Claimed	1.21 to 2.43	8 to 10	2 to 3	10 to 13	2 to 3
Found	1.28	8.97	1.14	10.11	2.15
Claimed	1 to 2	7 to 9	1 to 2	8 to 11	1 to 2
Found	1.	6.35	1.58	7.93	0.62
Claimed	....	14 to 16	1 to 2	15 to 18	....
Found	....	13.48	.72	14.20	....

Results of analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
The American Agricultu'l Chemical Co., New York City.........	Crocker's Ammoniated Bone Superphosphate	I. Van Dyke & Co., Zeeland...
The American Agricultu'l Chemical Co., New York City.........	Crocker's Ammoniated Wheat and Corn Phosphate	Manufacturer...................
The American Agricultu'l Chemical Co., New York City.........	Crocker's Dissolved Bone and Potash..................	C. L. Roeser, West Saginaw....
The American Agricultu'l Chemical Co., New York City.........	Crocker's General Crop Phosphate.......................	I. Van Dyke & Co., Zeeland...
The American Agricultu'l Chemical Co., New York City.........	Crocker's New Rival Ammoniated Superphosphate......	I. Van Dyke & Co., Zeeland....
The American Agricultu'l Chemical Co., New York City.........	Crocker's Universal Grain Grower......................	I. Van Dyke & Co., Zeeland....
The American Agricultu'l Chemical Co., New York City.........	Niagara Dissolved Bone with Potash	I. Van Dyke & Co., Zeeland....
The American Agricultu'l Chemical Co., New York City.........	Niagara Grain and Grass Grower......................	T. McClaughy, Romulus........
The American Agricultu'l Chemicol Co., New York City.........	Muriate of Potash...	P. W. Johnson, Pontiac........
The American Agricultu'l Chemical Co., New York City.........	Niagara Wheat and Corn Producer........................	Geo. L. Frank, West Bay City..
James Boland, Jackson, Mich......	Blackman......................	Reid Implement & Seed Co., Jackson......................
James Boland, Jackson, Mich......	Bone Meal......................	Reid Implement & Seed Co., Jackson.....................
Chicago Fertilizer Co., Chicago, Ill	Bone, Blood and Potash........	Presley & Layer, Bay City......
Chicago Fertilizer Co., Chicago, Ill	Potato, Truck and Tobacco Fertilizer....................	Presley & Layer, Bay City......
Chicago Fertilizer Co., Chicago, Ill	Wheat and Corn Special........	Manufacturer..................
Cincinnati Phosphate Co., St. Bernard, Ohio..................	Capital Dissolved Bone and Potash	Geo. Liscom, Goodrich.........
Cincinnati Phosphate Co., St. Bernard, Ohio..................	Capital Grain and Grass Grower	Philip Heigel, Goodrich........
Cincinnati Phosphate Co., St. Bernard, Ohio..................	Capital Wheat Grower	Manufacturer..................

for 1902, expressed in parts in a hundred.

	Available nitrogen, estimated as ammonia.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
		Available.	Insoluble.	Total.	
Claimed	2.99 to 3.98	9 to 11	1 to 2	10 to 13	2 to 3
Found	2.58	9.37	1.12	10.59	1.83
Claimed	2.49 to 3.64	8 to 10	1 to 2	9 to 12	1½ to 2½
Found	2.58	8.06	1.16	9.22	1.68
Claimed	....	10 to 12	1 to 2	11 to 14	2 to 3
Found	....	10.08	.64	10.72	2.25
Claimed	1 to 1.99	7 to 9	1 to 2	8 to 11	1 to 2
Found	.43	9.53	1.66	11.29	1.98
Claimed	1.49 to 2.49	9 to 11	1 to 2	10 to 13	2 to 3
Found	1.92	10.03	.94	10.97	1.99
Claimed	1 to 1.99	8 to 10	1 to 2	9 to 12	2 to 3
Found	1.39	8.39	1.61	10.	2.11
Claimed	....	10 to 12	1 to 2	11 to 14	2 to 3
Found	....	11.12	1.14	12.26	2.32
Claimed	1 to 1.99	7 to 9	1 to 2	8 to 11	1 to 2
Found	.97	6.85	2.21	9.06	0.88
Claimed	....	....	....	....	50.00
Found	....	....	....	....	60.15
Claimed	1.49 to 2.49	9 to 11	1 to 2	10 to 13	2 to 3
Found	1.56	9.69	1.36	11.05	1.59
Claimed	2.32	5.95	2.97	8.92	6.32
Found	.92	6.04	.18	6 22	7.61
Claimed	4.64	....	19.62	19.62	....
Found	4.91	3.66	15.52	19.18	....
Claimed	1½ to 2½	8 to 10	10 to 12	18 to 22	2 to 3
Found	1.60	8.73	1.56	10.39	1.82
Claimed	2 to 3	8 to 10	1 to 2	9 to 12	4 to 5
Found	2.02	8.78	1.34	10.12	4.68
Claimed	1 to 2	7 to 9	9 to 11	16 to 20	1 to 2
Found	1.51	6.70	1.84	8.54	2.28
Claimed	....	12 to 14	1 to 2	13 to 16	3 to 4
Found	....	11.92	2.78	14.70	2.07
Claimed	.97 to 1.94	10 to 12	1 to 2	11 to 14	1 to 2
Found	1.14	10.80	2.12	12.92	1.
Claimed	....	14 to 16	1 to 2	15 to 18	....
Found	....	12.06	3.42	15.48	....

Results of analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Darling & Co., Chicago, Ill.	Farmers' Favorite	Ashton, Buckhout & Ashton, Kalamazoo
Darling & Co., Chicago, Ill.	Pure Ground Bone	Chas. H. Kimball, Port Huron
Darling & Co., Chicago, Ill.	Sure Winner	Ashton, Buckhout & Ashton, Kalamazoo
Darling & Co., Chicago, Ill.	Two and Twenty Bone	Manufacturer
Darling & Co., Chicago, Ill.	Western Brand	L. D. Anderson, Armada
Darling & Co., Chicago, Ill.	Pure Bone and Potash	John Easton, Almont
Darling & Co., Chicago, Ill.	Acid Phosphate	F. N. Clark, Ludington
Darling & Co., Chicago, Ill.	Chicago Brand	Lewis Stead, Utica
Grand Rapids Glue Co., Grand Rapids, Mich.	Grand Rapids Brand	Perkins & Hess, Grand Rapids.
Jarecki Chemical Co., Sandusky, O	C. O. D. Phosphate	Wayman Coal Co., Wyandotte.
Jarecki Chemical Co., Sandusky, O	Lake Erie Fish Guano	Boutelle Bros., Bay City
Jarecki Chemical Co., Sandusky, O	No. 1 Fish Guano	Earl Goldsmith, Wayne
Jarecki Chemical Co., Sandusky, O	Fish and Potash, Potato and Tobacco Food	Boutelle Bros., Bay City
Detroit Sanitary Works, Detroit, Mich.	*Clover Leaf	
Michigan Carbon Works, Detroit	Banner Dissolved Bone	C. J. Cilley, Petersburg
Michigan Carbon Works, Detroit	Dessicated Bone	C. J. Cilley, Petersburg
Michigan Carbon Works, Detroit	Homestead A Bone Black Fertilizer	Bowen & Etheridge, Quincy

* No sample furnished for analysis.

for 1902, expressed in parts in a hundred.

	Available nitrogen, estimated as ammonia.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
		Available.	Insoluble.	Total.	
Claimed	3 to 3.99	8 to 10	2 to —	10 to —	4 to 5
Found	3.01	10.90	.66	11.56	4.30
Claimed	3.04 to 4.01	...	...	23 to 26	...
Found	2.92	4.30	18.08	22.38	...
Claimed	1 to 2	8 to 10	2 to —	10 to —	3 to 4
Found	1.28	8.90	1.70	10.60	2.75
Claimed	1.94 to 3.04	...	...	18 to 22	...
Found	2.21	7.00	10.64	17.64	...
Claimed	.5 to 1	7 to 9	2 to —	9 to —	½ to 1
Found	.68	7.78	1.44	9.22	0.75
Claimed	2.62 to 3.50	...	...	20.13 to 22.75	6 to 7
Found	2.69	11.62	8.32	19.94	7.72
Claimed	...	10 to 12	...	10 to 12	...
Found	...	7.68	.88	8.56	...
Claimed	2 to 3.04	8 to 10	2 to —	10 to —	2 to 3
Found	1.89	8.84	3.64	12.48	1.95
Claimed	4.86 to 6.07	5 to 7	6 to 8	11 to 15	1 to 2
Found	3.15	6.14	7.02	13.16	1.51
Claimed	...	14 to 15	1 to 2	15 to 17	...
Found	...	11.68	1.62	13.30	...
Claimed	1.99 to 3	10 to 12	1 to 2	11 to 14	1 to 2
Found	1.70	11.16	1.20	12.36	1.11
Claimed	1.04 to 1.99	10 to 12	1 to 2	11 to 14	1 to 2
Found	1.12	10.80	2.88	13.68	0.86
Claimed	1.04 to 1.99	8 to 9	1 to 2	9 to 11	4 to 5
Found	1.02	9.48	1.42	10.90	3.45
Claimed	2.43 to 3.64	7 to 9	1 to 2	8 to 11	2 to 3
Found	...	...	...	...	...
Claimed	...	30 to 34	...	30 to 34	...
Found	...	29.42	0.48	29.90	...
Claimed	1½ to 2½	...	...	25 to 30	...
Found	1.85	22.66	3.44	26.10	...
Claimed	2½ to 3½	8 to 11	...	8 to 11	1½ to 2½
Found	2.77	9.22	.72	9.94	2.12

Results of analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Michigan Carbon Works, Detroit..	Homestead Potato and Tobacco Fertilizer.............	J. H. Miller, Blissfield..........
Michigan Carbon Works, Detroit..	Red Line Complete Manure....	C. J. Cilley, Petersburg.........
Michigan Carbon Works, Detroit..	Red Line Crop Grower.........	Richmond Elevator Co., Lenox
Michigan Carbon Works, Detroit..	Red Line Phosphate...........	P. W. Johnson, Pontiac ....
Michigan Carbon Works, Detroit..	Red Line Phosphate with Potash..........................	J. H. Rowe, Flushing...........
Michigan Carbon Works, Detroit..	Homestead Sugar Beet Fertilizer......................	D. H. Pierce & Son, Ubly ......
Northwestern Fertilizer Co., Chicago, Ill........................	Horseshoe Brand Acidulated Bone	Manufacturer...................
Northwestern Fertilizer Co., Chicago, Ill........................	Horseshoe Brand Acidulated Bone and Potash...........	Frank Timmins, Deerfield......
Northwestern Fertilizer Co., Chicago, Ill........................	Horseshoe Brand Corn and Wheat Grower.............	N. B. Atwood, Caro............
Northwestern Fertilizer Co., Chicago, Ill........................	Garden City Superphosphate..	B. J. Albers, Zeeland...........
Northwestern Fertilizer Co., Chicago, Ill........................	Horseshoe Brand Potato Grower......................	Stephen & Morton, Benton Harbor......................
Northwestern Fertilizer Co., Chicago, Ill........................	Quick Acting Phosphate.......	Henry Lengemann, Imlay City
Northwestern Festilizer Co., Chicago, Ill........................	Horseshoe Brand Sugar Beet Fertilizer	N. B. Atwood, Caro............
Ohio Farmers' Fertilizing Co., Columbus, Ohio................	Ammoniated Bone and Potash.	D. W. Smith, Petersburg......
Ohio Farmers' Fertilizing Co., Columbus, Ohio................	Corn, Oats and Wheat Fish Guano	D. W. Smith, Petersburg.......
Ohio Farmers' Fertilizing Co., Columbus, Ohio................	General Crop Fish Guano......	D. W. Smith, Petersburg.......
Speidel & Schwartz, Grand Haven.	Celery Hustler.................	James Lock, Grand Haven.....
Swift & Co., Chicago, Ill..........	Ammoniated Bone............	A. F. Woodham Coal Co., Kalamazoo..................

for 1902, expressed in parts in a hundred.

	Available nitrogen, estimated as ammonia.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
		Available.	Insoluble.	Total.	
Claimed	2½ to 3½	8 to 11	....	8 to 11	3 to 4
Found	2.35	8.20	.76	8.96	1.99
Claimed	1 to 2	7 to 10	....	7 to 10	1 to 2
Found	1.21	7.68	1.18	8.86	1.92
Claimed	2 to 3.04	8 to 10	....	8 to 10	2 to 3
Found	2.07	8.10	.80	8.90	1.79
Claimed	....	14 to 16	....	14 to 16	....
Found	....	14.76	.34	15.10	....
Claimed	....	10 to 12	....	10 to 12	2 to 3
Found	....	9.42	.24	9.66	2.66
Claimed	1.49 to 2.49	9 to 11	....	9 to 11	2 to 3
Found	1.62	8.40	2 94	11.34	1.71
Claimed	1 to 1.99	10 to 12	2 to 3	12 to 15	....
Found	1.12	9.92	1.94	11.86	....
Claimed	1 to 1.99	10 to 12	2 to 3	12 to 15	1 to 1½
Found	1.16	9.66	2.14	11.80	1.52
Claimed	1.99 to 2.99	8 to 10	2 to 3	10 to 13	2 to 2½
Found	1.80	7.94	1.10	9.04	1.57
Claimed	2.49 to 3.48	8 to 10	2 to 3	10 to 13	1½ to 2
Found	2.72	8.16	.90	9.06	2.02
Claimed	2.99 to 3.99	9 to 10	2 to 3	11 to 13	2 to 3
Found	2.33	10.60	1.88	12.48	0.98
Claimed	....	10 to 12	2 to 3	12 to 15	....
Found	....	9.56	.38	9.94	....
Claimed	1.49 to 2.49	9 to 11	1 to 2	10 to 13	2 to 3
Found	1.74	9.82	1.06	10.98	1.67
Claimed	1 to 2	8 to 10	2 to 3	10 to 13	4 to 6
Found	2.31	8.20	1.48	9.68	3.15
Claimed	1.51 to 2.43	8 to 10	2 to 3	10 to 13	2 to 4
Found	1.79	8.90	1.02	9.92	3.46
Claimed	1 to 2	7 to 9	2 to 3	9 to 12	1 to 2
Found	1.99	7.48	1.20	8.68	2.17
Claimed	8½ to 9.71	3.17 to 3.40	.69 to 1.41	3.86 to 4.81	1.25 to 2.38
Found	8.15	2.14	.84	2.98	1.93
Claimed	6.07 to 7.28	....	....	17 to 18	....
Found	5.09	13.06	3.06	16.12	....

Results of analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Swift & Co., Chicago, Ill.	Ammoniated Bone and Potash.	F. C. Goddene, Bay City
Swift & Co., Chicago, Ill.	Swift's Bone and Potash	Malachi Cox, Schoolcraft
Swift & Co., Chicago, Ill.	Bone Meal	R. A. Snyder, Chelsea
Swift & Co., Chicago, Ill.	Complete Fertilizer	Hart & Sullivan, Almont
Swift & Co., Chicago, Ill.	Diamond S Phosphate	Isbell & Co., Jackson
Swift & Co., Chicago, Ill.	Onion Grower	R. A. Snyder, Chelsea
Swift & Co., Chicago, Ill.	Onion and Potato Special	H. DeKruif, Zeeland
Swift & Co., Chicago, Ill.	Potato and Tobacco Grower	S. M. Isbell & Co., Jackson
Swift & Co., Chicago, Ill.	Raw Bone Meal	Marshall Bros., Imlay City
Swift & Co., Chicago, Ill.	Special Potato Fertilizer	Manufacturer
Swift & Co., Chicago, Ill.	Sugar Beet Grower	H. DeKruif, Zeeland
Swift & Co., Chicago, Ill.	Superphosphate	H. DeKruif, Zeeland
Swift & Co., Chicago, Ill.	Vegetable Grower	G. Lavender, Pittsfield
Swift & Co., Chicago, Ill.	Champion Wheat Grower	Manufacturer
Swift & Co., Chicago, Ill.	Champion Corn Grower	Mr. Woelmer, Strasburg
Swift & Co., Chicago, Ill.	Phosphate and Potash	Manufacturer
Phœnix Manufacturing Co., Ann Arbor, Mich.	Huron Valley Brand	J. F. Barth, Chelsea

for 1902, expressed in parts in a hundred.

	Available nitrogen, estimated as ammonia.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
		Available.	Insoluble.	Total.	
Claimed	5.77 to 6.98			16 to 17	3 to 4
Found	5.29	11.72	6.94	18.66	1.48
Claimed	3.04 to 3.95			23½ to 26	3 to —
Found	2.98	8.24	13.24	21.48	3.01
Claimed	3.04 to 3.95			25 to 27½	
Found	3.12			21.88	
Claimed	1.21 to 2.12	8 to 10	3 to 5	11 to 15	1 to 2
Found	1.29	9.85	2.20	12.05	1.89
Claimed		10 to 12	1 to 2	11 to 14	
Found		9.50	.98	10.48	
Claimed	3.04 to 3.95	8 to 10	3 to 5	11 to 15	7 to 8
Found	2.73	11.22	.48	11.70	5.86
Claimed	1.99 to 3	8 to 10	3 to 5	11 to 15	7 to 8
Found	4.93	8.12	.54	8.66	9.52
Claimed	3.95 to 4.86	10 to 12	1 to 3	11 to 15	5 to 6
Found	5.61	8.86	.86	9.72	6.17
Claimed	4.55 to 5.46			23 to 27½	
Found	4.27			20.85	
Claimed	3 to 3.99	10 to 12	3 to 4	13 to 16	3 to 4
Found	3.19	11.06	1.62	12.68	2.65
Claimed	3.04 to 3.95	8 to 10	3 to 5	11 to 15	5 to 6
Found	2.68	7.25	3.05	10.30	4.56
Claimed	1.99 to 3	8 to 10	4 to 8	12 to 18	2 to 3
Found	1.70	8.58	2.34	10.92	2.05
Claimed	3.95 to 4.86	9 to 11	1 to 3	10 to 14	10 to 11
Found	4.60	6.12	2.72	8.84	8.71
Claimed	1.99 to 3	12 to 14	1 to 3	13 to 17	2 to 3
Found	2.15	13.54	1.80	15.34	1.97
Claimed	1.99 to 3	12 to 14	1 to 3	13 to 17	2 to 3
Found	1.53	12.50	3.22	15.72	2.48
Claimed		12 to 14	1 to 2	13 to 16	2 to 3
Found		11.08	3.00	14.08	1.61
Claimed	1.52 to 2.43	8 to 10	1 to 4	9 to 14	2.75 to 4
Found	3.18	12.38	.78	13.16	2.33

Results of analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
The Albert Dickinson Seed Co., Chicago, Ill	Globe Brand all Grain Fertilizer	Manufacturer
The Albert Dickinson Seed Co., Chicago, Ill	Globe Brand Lawn Fertilizer	G. R. Hurd Sons Co., Monroe
Joseph Lister, Chicago	Pure Bone Meal	August Schneidt, Jr., Muskegon

The following brands of fertilizers have not been

Manufacturer.	Trade name.	Dealer and locality.
Swift & Co., Chicago	Sulphate of Potash	R. A. Snyder, Chelsea
Darling & Co., Chicago	Vegetable and Lawn Fertilizer	Theodore Ruff, St. Clair

* The sale of an unlicensed fertilizer renders the dealer liable to a fine of $100. See law, Sec. 6.

for 1902, expressed in parts in a hundred.

	Available nitrogen, estimated as ammonia.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
		Available.	Insoluble.	Total.	
Claimed................	1.99 to 3.95	8 to 10	4 to 8	12 to 18	2 to 3
Found..................	2.42	7.88	4.78	12.60	2.37
Claimed................	4.55 to 5.46	23 to 27½	....	23 to 27½	....
Found..................	4.73	12.78	9.72	22.50	....
Claimed................	2.72 to 4	11.50 to 15	12.10 to 15.08	23.60 to 30.08	....
Found..................	2.86	9.12	12.36	21.48	....

*licensed and their sale in this State is unlawful.**

	Available nitrogen, estimated as ammonia.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
		Available.	Insoluble.	Total.	
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....

MICHIGAN STATE AGRICULTURAL SOCIETY.

REPORT OF THE TRANSACTIONS OF THE SOCIETY FOR THE YEAR 1901, AND PROCEEDINGS OF THE WINTER MEETING, AND OTHER MEETINGS OF THE EXECUTIVE COMMITTEE PREVIOUS TO JUNE 30, 1902.

OFFICERS FOR 1901.

President—M. P. ANDERSON, Midland.
Vice-President—L. J. RINDGE, Grand Rapids.
Treasurer—C. W. YOUNG, Paw Paw.
Secretary—I. H. BUTTERFIELD, Agricultural College.

EXECUTIVE COMMITTEE.

Term ending January, 1902.

E. W. Hardy	Howell, Livingston County.
Frank Maynard	Jackson, Jackson County.
F. L. Reed	Olivet, Eaton County.
S. O. Bush	Battle Creek, Calhoun County.
H. R. Dewey	Grand Blanc, Genesee County.
R. D. Graham	Grand Rapids, Kent County.
John Lessiter	Pontiac, Oakland County.
H. H. Hinds	Stanton, Montcalm County.
F. E. Skeels	Harriette, Wexford County.
Dexter Horton	Fenton, Genesee County.

Term ending January, 1903.

Eugene Fifield	Bay City, Bay County.
L. W. Barnes	Byron, Shiawassee County.
W. P. Custard	Mendon, St. Joseph County.
William Ball	Hamburg, Livingston County.
W. E. Boyden	Delhi Mills, Washtenaw County.
Eugene W. Jones	Grand Rapids, Kent County.
J. E. Rice	Grand Rapids, Kent County.
C. A. Waldron	Tecumseh, Lenawee County.
John McKay	Romeo, Macomb County.
John A. Hoffman	Kalamazoo, Kalamazoo County.

EX-PRESIDENTS.

Members Ex-Officio.

W. L. Webber	Saginaw, Saginaw County.
George W. Phillips	Romeo, Macomb County.
William Chamberlain	Jackson, Jackson County.
A. O. Hyde	Marshall, Calhoun County.
T. W. Palmer	Detroit, Wayne County.

STANDING COMMITTEES AND EXECUTIVE SUPERINTENDENTS.

BUSINESS.

Eugene Fifield, H. H. Hinds and Secretary.

TRANSPORTATION.

H. H. Hinds, S. O. Bush, D. Horton.

PROGRAM.

Eugene Fifield, J. E. Rice, Secretary.

PRINTING AND ADVERTISING.

I. H. Butterfield, Eugene Fifield, H. R. Dewey.

PREMIUM LIST.

W. E. Boyden, E. W. Hardy, Wm. Ball, L. W. Barnes,
F. L. Reed, Frank Maynard, John McKay.

RULES.

Eugene Fifield, H. H. Hinds, D. Horton.

FINANCE.

R. D. Graham, E. W. Jones, John McKay.

GENERAL SUPERINTENDENT.

Eugene Fifield.

CHIEF MARSHAL.

H. H. Hinds.

EXECUTIVE SUPERINTENDENTS.

Cattle—W. E. Boyden.
Horses, Speed—Eugene Fifield.
Horses, Roadster, Draft and Pony Classes—H. H. Hinds.
Sheep—Wm. Ball.
Swine—L. W. Barnes.
Poultry—C. A. Waldron.
Dairy, Bees and Honey—John McKay.
Farm and Garden Products—F. L. Reed.
Vehicles—Dexter Horton.
Agricultural Implements and Machinery—John A. Hoffman.
Manufactured Goods and Supt. of Main Building—F. E. Skeels.
Art—A. H. Griffith.
Needle Work and Children's Work—Mrs. S. Tobin.
School Exhibits—Frank Maynard.
Horticulture—R. D. Graham.
Gates—W. P. Custard.
Police—E. W. Hardy.
Forage—John Lessiter.
Booths and Privileges—H. R. Dewey.
Miscellaneous Exhibits—John McKay.

PROCEEDINGS OF THE EXECUTIVE COMMITTEE.

A meeting of the committee was held at the Hodges House, Pontiac, Monday evening, September 23, 1901.

There were present Messrs. Maynard, Reed, Dewey, Hinds, Skeels, Horton, Fifield, Barnes, Custard, Ball, Waldron, McKay, Hoffman, President, Treasurer, Secretary.

The matter of building closets was referred to the President and Mr. Maynard.

The buildings contracted for by the Oakland County Agricultural Society being practically completed were turned over to the State Society for the Fair.

It was moved that the caucus of the society be held at the President's reception room at 4 o'clock standard time on Wednesday, September 25.

J. E. Barringer of Armada, E. T. Parks of Paw Paw, and D. P. Dewey of Grand Blanc were appointed judges of election.

It was resolved that this committee recommend to the society at its caucus meeting on Wednesday that the constitution be amended so that members of the executive committee shall receive three dollars per day for not to exceed ten days services during the year; also that an amendment be made providing that not more than two members of the executive committee shall be elected or serve from any one county at the same time.

It was resolved that the rule prohibiting the award of more than one prize to an animal shall be construed that an animal shown for the single prize may also show for the herd or sweepstake prize in the same class and for no other.

Adjourned.

CAUCUS.

A caucus of the Society was held at the reception room of the President on the fair grounds at 4 o'clock p. m. Wednesday, September 25. William Ball was called to the chair and I. H. Butterfield elected secretary.

The following was offered by Mr. F. H. Jacobs as an amendment to the constitution to be voted on at the annual election on September 26: That article two be amended so as to read regarding election of members of the executive committee that "no more than two members of the executive committee shall be elected or serve from any one county at the same time."

The motion was adopted and the amendment ordered voted on at the annual election.

Mr. M. P. Anderson offered the following as an amendment to article nine of the constitution to be voted on at the annual election:

The executive committee shall receive pay at the rate of three dollars per day from and including Thursday of the week preceding the fair, not to exceed ten days in all, and for only such time as they are actually in attendance during this period, and all actual and necessary expenses while engaged in the performance of their duties as such members. The president's salary shall be one hundred dollars per year and actual expenses while engaged in the performance of his duties as such officer.

The motion was adopted and ordered voted on at the annual election.

On motion the caucus proceeded to the nomination of officers. It was moved to vote by ballot. Moved to amend by voting viva voce. Carried. On motion, the following persons were nominated:

For president, Milton P. Anderson of Midland; for vice president, Stephen Baldwin of Detroit; for treasurer, Chas. W. Young of Paw Paw; for secretary, Ira H. Butterfield of Agricultural College.

For members of the executive committee for two years:

Eph. Howland of Pontiac, Frank Maynard of Jackson, William W. Collier of Detroit, Daniel L. Davis of Pontiac, Hiram R. Dewey of Grand Blanc, John Marshall of Cass City, Byron E. Hall of Port Huron, Henry H. Hinds of Stanton, Fremont E. Skeels of Harriette, Dexter Horton of Fenton.

On motion adjourned.

ELECTION.

Held at the office of the president Thursday, September 26, 1901.

Mr. E. T. Parks, one of the judges appointed, not being present, J. W. Cochrane of Midland was appointed in his stead by the president.

John E. Barringer was elected chairman.

The judges were sworn in by William Ball, notary public. The polls were opened at nine o'clock a. m. and closed at five o'clock p. m.

The following is the report of the judges of election:

Vote on amendments to constitution. Amendments relative to salaries of officers. Yes, 148 votes; no, 16 votes. Amendment relative to limiting the members of the executive committee from any one county. Yes, 143 votes; no, 17 votes.

For officers:

For president, Milton P. Anderson of Midland county, 204 votes.

For vice president, Stephen Baldwin of Wayne county (Detroit), 203 votes.

For treasurer, Charles W. Young of Van Buren county, 204 votes.

For secretary, Ira H. Butterfield of Ingham county, 204 votes.

For members of the executive committee for two years: Ephraim Howland of Oakland county, 204 votes; Frank Maynard of Jackson county, 204 votes; William W. Collier of Wayne county, 204 votes; Daniel L. Davis of Oakland county, 25 votes; Hiram R. Dewey of Genesee county, 204 votes; John Marshall of Tuscola county, 204 votes; Byron E. Hall of St. Clair county, 204 votes; Henry H. Hinds of Montcalm county, 204 votes; Fremont E. Skeels of Wexford county, 204 votes; Dexter Horton of Genesee county, 204 votes; George H. German of Oakland county, 179 votes.

Signed,

JOHN E. BARRINGER,
D. P. DEWEY,
J. W. COCHRANE,
Judges of Election.

On report of the judges the persons above named, except Daniel L. Davis, were declared elected by the president and the amendments to the constitution carried.

THE FAIR OF 1901.

The annual fair of the society was held on the grounds of the Oakland County Agricultural Society at Pontiac, September 23-27, inclusive.

The weather was fine and the attendance the largest with one exception in the history of the society. The exhibit of live stock was large, and that in farm implements, carriages and fruit was above the average.

There was some lack in transportation or the attendance on some days would have been larger. The reports of the secretary, treasurer and business committee made at the winter meeting will show the financial results of the fair.

WINTER MEETING OF THE EXECUTIVE COMMITTEE 1902.

OFFICERS FOR 1902.

President—M. P. ANDERSON, Midland.
Vice-President—STEPHEN BALDWIN, Detroit.
Treasurer—C. W. YOUNG, Paw Paw.
Secretary—I. H. BUTTERFIELD, Agricultural College.

EXECUTIVE COMMITTEE.

Term ending January, 1903.

Eugene Fifield	Bay City, Bay County.
L. W. Barnes	Byron, Shiawassee County.
W. P. Custard	Mendon, St. Joseph County.
William Ball	Hamburg, Livingston County.
W. E. Boyden	West Bay City, Bay County.
Eugene W. Jones	Grand Rapids, Kent County.
J. E. Rice	Grand Rapids, Kent County.
C. A. Waldron	Tecumseh, Lenawee County.
John McKay	Romeo, Macomb County.
John A. Hoffman	Kalamazoo, Kalamazoo County.

Term ending January, 1904.

E. W. Hardy	Howell, Livingston County.
Frank Maynard	Jackson, Jackson County.
H. R. Dewey	Grand Blanc, Genesee County.
H. H. Hinds	Stanton, Montcalm County.
F. E. Skeels	Harriette, Wexford County.
Eph. Howland	Pontiac, Oakland County.
W. W. Collier	Detroit, Wayne County.
Byron E. Hall	Port Huron, St. Clair County.
John Marshall	Cass City, Tuscola County.
Geo. H. German	Franklin, Oakland County.

EX-PRESIDENTS.

Members Ex-Officio.

A. O. Hyde	Marshall, Calhoun County.
T. W. Palmer	Detroit, Wayne County.

The annual winter meeting of the executive committee was held at the Hodges House, Pontiac, February 18, 1902, there having been no members present at the meeting called on the regular date—the second Monday in January.

All members present except Mr. Ball and Mr. Horton. Mr. Horton deceased since the fair.

The matter of protests filed at the fair were taken up:

1. Protest of A. B. Lewis of Pontiac in class 45—for reason that the quality and market value of the roots and vegetables were not taken into consideration. Protest not allowed and premiums ordered paid as awarded.

2. Protest of G. W. Bell of Yale, against award on lot 160, class 10, stallion four years old or over. Reason, that this lot was not viewed by the regular judge. Protest not allowed and the premiums ordered paid as awarded.

3. Protest of Elmdale Farm against award in lot 284, pair mares or geldings four years old or over, grade draft. The team entered by the protestant being ruled out by the superintendent because one was a mare and one a gelding. Protest sustained and second premium ordered paid to Elmdale Farm.

4. Protest of Geo. E. Seeley against award of second premium to entry 470, in lot 165, class 10, yearling stallion, claiming that he is not registered nor eligible to registry. On testimony of owner of stallion, Mr. A. G. Hadsell, the protest was sustained and the second premium in that lot ordered paid Geo. E. Seeley & Son.

5. Protest of B. D. Kelley & Son against award in lot 192, class 14, all work, because the superintendent ruled out pair horses because they were not of the same sex. Protest sustained and premium ordered paid.

6. Protest of Martin Crocker against the award in lot 164, class 10, stallions two years old, standard bred, claiming that the stallion owned by Rufus Ivory of Hadley, Mich., is not registered. It being shown that the stallion named had been registered since the fair, showing that he was eligible to registry, and owing to the difference in wording of the general and the specific rules relating to registry, the protest was not sustained.

7. Protest of Delos Leavenworth against award in lot 286, class 20, grade draft mare 4 years old, as published in the premium list, for the reason that the premium was awarded to a gelding. It was shown that the omission of the word gelding was a printer's error, and that it was understood that the list should have read mare or gelding, the protest was not sustained.

8. Protest of A. H. Warren of Ovid, against all awards to Robert Knight & Son of Marlette, in class 25, Leicester sheep, on the ground that Mr. Knight did not comply with the rule requiring all exhibits to be in place on Monday morning, September 23, at nine o'clock a. m. Mr. Knight having stated that he made proper effort to have his stock on exhibition at the proper time but was delayed by the railway company, the protest was not sustained and premiums awarded Mr. Knight were ordered paid.

Superintendents of departments reported as follows:

CATTLE.

To the President and Members of the Executive Committee:

Gentlemen—As superintendent of the cattle department at your most successful State Fair of 1901, I submit the following report:

The whole number of entries of cattle was 458; all that could be accommodated in the cattle sheds. The entries in each class and the amounts awarded will be found in the report of the secretary.

The exhibit as a whole was very creditable, and so far as I was able to learn was as free from any dissatisfaction with decisions of judges, as it has been my fortune to experience during the time I have had the honor of being superintendent of this department.

I have nothing at this time to offer by way of recommendation except that the closets about the cattle department receive proper attention.

Signed,

W. E. BOYDEN,
Superintendent.

HORSES.

H. H. Hinds, superintendent of horses, made a verbal report, recommending that the rent for box stalls should be $1.50.

The exhibit of horses was light but the quality of those shown was good.

Eugene Fifield, superintendent of speed, submitted the following report of the races:

2:40 class, trotting, eight entries, $400 paid, $240 received for entries; 2:14 class, pacing, five entries, $400 paid, $180 received; 2:40 class, pacing, nine entries, $400 paid, $260 received; 2:19 class, trotting, four entries, $400 paid, $160 received; 2:24 class, trotting, six entries, $400 paid, $200 received; 2:23 class, pacing, six entries, $400 paid, $200 received; 2:30, trotting, five entries, $360 paid, $210 received; 2:30, pacing, nine entries, $400 paid, $260 received; 2:19 class, pacing, nine entries, $400 paid, $260 received; 2:14 class, trotting, five entries, $400 paid, $180 received; free for all pacing, six entries, $400 paid, $200 received.

SUMMARY.

Receipts account speed department:—		
Entrance money and five per cent of purses paid	$2,290 00	
Collected since the fair	33 00	
Collected on suspension of 1901	15 75	
Pool and score card privileges sold	450 00	
One-half grand stand receipts, $3,116.75, credited to speed	1,558 37	
Total	$4,347 12	
Disbursements account speed department:—		
Purses paid	$4,360 00	
Advertising speed	45 00	
Membership American Association	50 00	
Clerk speed department	125 00	
Total	$4,580 00	
Net cost of speed department		$233 88

REPORT OF THE SUPERINTENDENT OF SHEEP.

To the President and Executive Committee of the Michigan State Agricultural Society:

GENTLEMEN—The exhibition of sheep at the fair held in Pontiac last September was an exceptionally good one. The different breeds represented were as follows: American Merino, Rambouillet, Delaine, Cotswold, Lincoln, Leicester, Shropshire, Hampshire, Oxford, Southdown and fat sheep.

The rule requiring sheep to be evenly and closely shorn, and a certification of the time of shearing when making entries, was utterly ignored so far as I could learn. It is my judgment that some date should be fixed as a limit for shearing sheep to be shown at the State Fair. I would suggest that no sheep should be shown that were sheared before the first of March preceding the fair.

There is no class of animals in which jockeying can be as successfully pursued as in fitting sheep for show by stubble shearing, shearing to cover defects, coloring fleece, etc. Too much care cannot be taken in the adoption of rules to prevent the methods of deception mentioned.

The space allotted for sheep was inadequate for the number shown, and the horse barn in which the overflow was quartered was not a suitable place in which to show sheep. Some fault was found by exhibitors who were obliged to use the barn, but on the whole they submitted cheerfully to the inconvenience. As long as two sets of premiums are offered large numbers of sheep will be shown, and if possible they should be provided for.

The whole number of sheep shown was 746; much the largest number ever shown at the State Fair.

The entries in the several classes, amount offered and amount awarded will be found in the report of the secretary.

Respectfully submitted,
WILLIAM BALL,
Superintendent of Sheep.

REPORT OF THE SUPERINTENDENT OF SWINE.

To the President and Members:

GENTLEMEN—I respectfully submit the following report:

The exhibit of swine at the fair of 1901 was in my judgment one of the very best in quality as well as number ever made at the fair. There were 550 head of the several breeds on the ground. The pens provided for swine would accommodate but about one-half of the number and a large number of exhibitors were compelled to exhibit in the horse barns. The exhibitors were very considerate and good feeling prevailed.

It is hoped that more room will be provided at the next fair. The tabulation of entries and awards will be found in the report of the secretary.

Very respectfully,
L. W. BARNES,
Superintendent.

POULTRY.

The exhibit of poultry was not quite so large as usual, partly owing to the list being confined to the State. The total of entries was 876. More room is needed for the poultry.

Respectfully,
C. A. WALDRON,
Superintendent.

FARM AND GARDEN PRODUCTS, SEEDS, GRAIN AND VEGETABLES.

The exhibit in division F at the last fair was not up to the standard of past years. The whole number of entries was 304, as against 454 in 1899 and 540 in 1900. The exhibits were as usual very good. To the offer of premiums for county exhibits the county of Alpena responded with a fine display of agricultural products and manufactured goods. There was a small exhibit from Menominee county with promise of a larger one in 1902.

These county exhibits will do much to bring the value of these upper counties agriculturally before the people.

F. L. REED,
Superintendent.

DAIRY, BEES AND HONEY.

To the President and Members of Executive Committee:

In class 47, butter and cheese, the exhibits were above the average in quality. The number of entries of butter was 45 and of cheese, 28.

In class 48 the number of entries was 38. In division H there was but one exhibitor with 15 entries.

Respectfully,
JOHN McKAY,
Superintendent.

FARM IMPLEMENTS AND MACHINERY.

Mr. President and Members of the Executive Committee of the Michigan State Agricultural Society:

The farm implement and machinery department begs leave to report a great number of exhibitors at the last fair. They came from a great distance; from the northwest as far as Minnesota, extreme west Iowa, southwest Missouri and as far east as the New England states, all showing great interest to make it as fine an exhibit as possible. We were not short of room, hence were able to please all for space. The manufacturers are showing great interest in attending fairs of late.

We cannot help but look for a good show at our fair of 1902.

One year ago I asked for two premiums; one on exhibits from outside the State and one to Michigan exhibits, which was not granted. I renew the request. I believe that it is no more than fair that this department should receive something at the hands of the executive committee as well as other departments which do not contribute near so much to the fair.

Thanking you one and all for your assistance, I respectfully submit this report.

JOHN A. HOFFMAN.
Superintendent.

MANUFACTURES AND MAIN BUILDING.

To the officers and Members of the Executive Committee of the Michigan State Agricultural Society:

GENTLEMEN—As superintendent of manufactures and main building I submit my report:

In division L there were seven entries of samples of wool and $30 in prizes were awarded. There were nine entries of furniture and three diplomas awarded. In the main building there was a great lack of room. Several fine exhibits were refused on this account. The floor space in the main building is several hundred square feet less than the building previously used, and a portion of this space is used for fruits and flowers, which were formerly shown in a separate building; while the dairy exhibit occupied a large portion of one wing, these two divisions having a much larger display than usual reduced the space for other exhibits materially.

It will be necessary to cover the ceiling above fruit hall to prevent dust sifting through and spoiling the appearance of fruit; also some minor changes should be made in the floor.

Respectfully,
F. E. SKEELS,
Superintendent.

FRUITS AND FLOWERS.

Owing to the illness of Supt. Graham, M. L. Dean of Agricultural College, was called on to take charge of this department and assumed charge on Saturday evening. Notwithstanding the delay Mr. Dean got the exhibit arranged in good time and in fine shape considering the crowded condition of the hall. The following is his report:

After investigating the newly constructed buildings and allotting space in horticultural hall, it was found that table room was wanting, but through the efforts of Supt. Skeels the tables were rearranged and enlarged so as to permit a crowded arrangement of the exhibits.

The entire exhibit was too crowded to show at its best. We had enough to have filled another table four feet wide and 100 feet long.

The horticultural department of the Michigan State Fair is one of the most important divisions of the exhibit. The fruit interests are not in the kindergarten stage, but are now among the important industries of the State, and statistics show but few enterprises that represent disbursements equivalent to those for fruits and flowers.

We have promising sections that need some encouragement along the lines of fruit production as well as in other agricultural products, viz: The northern counties of the lower peninsula, and the upper peninsula, where fruit growing is in its infancy; but even now we look to these sections to produce fruit of the highest quality. In connection with this most desirable feature of the premiums offered were the awards for county exhibits, although I believe they are somewhat restricted.

There were ten counties represented: Alcona, Alpena, Cheboygan, Charlevoix, Emmet and Grand Traverse. Crawford had a small show. From the upper peninsula section Menominee and Marquette had very creditable exhibits, and Baraga sent fruit of exceptional perfection. The general collections were a credit to our fruit interests.

The entire exhibit of 1901 covered about 2,500 square feet of table space and consisted of about 6,000 plates of fruit, divided as follows: 3,000 plates of apples, 900 of peaches, 600 of pears, 750 of plums, 650 of grapes, crab apples, quinces and cranberries.

There were some complaints by exhibitors, but the rushed condition of affairs owing to the imcompleteness of the newly constructed buildings was responsible for nearly all.

I recommend that plants and flowers be arranged separately but in close proximity to fruit. The floor above the fruit should be dust tight. The fruit tables should be lowered for convenience of arranging and handling fruit as well as for visitors.

Several changes in the premium list are recommended—enlarging the list and giving third premiums in collections.

M. L. DEAN,
Acting Superintendent.

REPORT OF THE SUPERINTENDENT OF GATES.

To the President and Members of the Executive Committee:

Gentlemen—I submit the following: I employed ten men at the gates at $2.50 each per day and railroad fare and one man to take tickets at grand stand one-half day at $1.00 per day, a total of $156.83.

Being short of help at the grand stand, the police department helped out very courteously.

I recommend that a gate for teams be made west of the offices.

W. P. CUSTARD,
Superintendent.

POLICE.

Gentlemen—I submit the following report of the police department: Good order was maintained through the entire fair. Much credit is due Sheriff Brewster and his men for the assistance they rendered during the fair. Summary—Total number of men employed, 61; pay roll, $675.40; fines collected, $3.70.

E. W. HARDY,
Superintendent.

CONCESSIONS AND PRIVILEGES.

To the President and Gentlemen of the Executive Committee:

The receipts from privileges were larger than usual, but this department is hampered for space. The total receipts for privileges were $4,058.63. More check room should be provided.

H. R. DEWEY,
Superintendent.

The secretary reported receipts as follows:

From American Short Horn Breeders' Association........	$452 50
From Michigan Short Horn Breeders' Association............	35 00
From Davis & Vannier, rent of tent, fair 1900..............	16 00
From American Trotting Association, fines collected........	15 65
From State Treasurer, appropriation......................	4,500 00
From memberships sold..................................	533 00
From stall fees collected.................................	237 65
Total	$5,789 80

Which has been paid to the treasurer.

I. H. BUTTERFIELD,
Secretary.

Report received and referred to the finance committee.

REPORT OF THE TREASURER.

To the Members of the Executive Committee:

GENTLEMEN—I herewith submit my annual report as treasurer of the Society for the year 1901:

RECEIPTS.

Balance on hand from 1900	$3,543 99
Received from general admissions	22,474 80
" " admissions to grand stand	3,116 75
" " H. R. Dewey, privileges	2,277 31
" " G. S. Ward, speed entries	2,330 00
" " E. Fifield, privileges	1,881 32
" " secretary, stall rents and miscellaneous	304 30
" " memberships, secretary sold	533 00
" " memberships, treasurer sold	142 00
" " E. W. Hardy, police superintendent	8 55
" " John McKay, superintendent	1 25
" " secretary Short Horn Breeders' Association	452 50
" " received from R. R. coupon admissions	4,701 75
" " returned business order	14 22
" " secretary, appropriation by State	4,500 00
Total	$46,281 74

DISBURSEMENTS.

To paid on business orders and race premiums	$16,999 16
To paid on premium orders	10,370 09
Total	$27,369 25
Balance on hand	18,912 49
Total	$46,281 74

C. W. YOUNG,
Treasurer.

Report received and referred to the finance committee.

The secretary's report of number of entries and amounts offered and awarded in the several classes.

Division A—Cattle.

	Number entries.	Amount offered.	Amount awarded.
Shorthorns, open to all	64	$500 00	$423 00
Shorthorns, open to Michigan	87	500 00	482 00
Devons, open to all	11	285 00	114 00
Devons, open to Michigan	0	222 00	......
Herefords, open to all	35	285 00	229 00
Herefords, open to Michigan	19	222 00	192 00
Jerseys, open to all	43	285 00	253 00
Jerseys, open to Michigan	27	222 00	165 00
Galloways, open to all	23	285 00	228 00
Galloways, open to Michigan	25	222 00	182 00
Aberdeen Angus, open to all	26	285 00	189 00
Aberdeen Angus, open to Michigan	9	222 00	83 00
Holstein Friesian, open to all	27	285 00	111 00
Holstein Friesian, open to Michigan	0	222 00	......
Red Polled, open to all	21	285 00	221 00
Red Polled, open to Michigan	17	222 00	140 00
Fat Cattle	20	129 00	116 00
Totals	454	$4,678 00	$3,128 00

Division B—Horses.

	Number entries.	Amount offered.	Amount awarded.
Standard Bred	47	$267 00	$244 00
Roadsters, not standard	19	138 00	72 00
Carriage	19	160 00	99 00
Saddle	1	36 00	11 00
All Work	19	236 00	80 00
Cleveland Bay, open to all	0	233 00	......
Cleveland Bay, open to Michigan	0	171 00	......
French Coach, open to all	0	233 00	......
French Coach, open to Michigan	0	171 00	......
Hackney, open to all	1	233 00	14 00
Hackney, open to Michigan	3	171 00	36 00
Percheron, open to all	6	233 00	57 00
Percheron, open to Michigan	7	171 00	43 00
Clydesdale or Shire, open to all	9	233 00	57 00
Clydesdale or Shire, open to Michigan	0	171 00	......
Grade Draft	16	135 00	86 00
Shetland Ponies	5	50 00	50 00
Fancy Coach Teams	0	100 00	......
Totals	152	$3,142 00	$849 00

Division C—Sheep.

	Number entries.	Amount offered.	Amount awarded.
American Merino, open to all	54	$168 00	$154 00
American Merino, open to Michigan	45	168 00	156 00
Rambouillet Merino, open to all	77	126 00	126 00
Rambouillet Merino, open to Michigan	69	126 00	126 00
Delaine Merino, open to all	23	126 00	59 00
Delaine Merino, open to Michigan	16	126 00	69 00
Lincoln, open to all	37	114 00	102 00
Lincoln, open to Michigan	36	114 00	102 00
Leicester, open to all	24	114 00	70 00
Leicester, open to Michigan	28	114 00	98 00
Cotswold, open to all	40	114 00	109 00
Cotswold, open to Michigan	21	114 00	103 00
Shropshire, open to all	92	126 00	126 00
Shropshire, open to Michigan	76	126 00	126 00
Hampshire, open to all	39	114 00	104 00
Hampshire, open to Michigan	25	114 00	111 00
Oxford, open to all	55	114 00	104 00
Oxford, open to Michigan	31	114 00	109 00
Southdown, open to all	14	114 00	94 00
Southdown, open to Michigan	21	114 00	77 00
Horned Dorset, open to all	0	114 00	......
Horned Dorset, open to Michigan, not shown	7	114 00	......
Fat Sheep	22	54 00	45 00
Totals	852	$2,742 00	$2,170 00
Offered by the Hampshire Down Breeders' Ass'n		40 00	40 00
Offered by the Oxford Down Breeders' Ass'n		30 00	30 00
Totals		$2,812 00	$2,240 00

Division D—Swine.

	Number entries.	Amount offered.	Amount awarded.
Berkshire, open to all	52	$132 00	$132 00
Berkshire, open to Michigan	48	132 00	107 00
Essex, open to all	26	132 00	107 00
Essex, open to Michigan	13	132 00	62 00
Small Yorkshire, open to all	29	132 00	120 00
Small Yorkshire, open to Michigan	13	132 00	62 00
Poland China, open to all	39	132 00	122 00
Poland China, open to Michigan	17	132 00	81 00
Duroc Jersey, open to all	88	132 00	127 00
Duroc Jersey, open to Michigan	54	132 00	132 00
Chester White, etc., open to all	64	132 00	132 00
Chester White, etc., open to Michigan	25	132 00	102 00
Victoria, open to all	77	132 00	132 00
Victoria, open to Michigan	72	132 00	132 00
Tamworth, open to all	17	132 00	12 00
Tamworth, open to Michigan	4	132 00	12 00
Totals	638	$2,112 00	$1,574 00

Division E—Poultry.

	Number entries.	Amount offered.	Amount awarded.
Totals	876	$543 00	$309 00

Grain, Seeds and Vegetables.

		Number entries.	Amount offered.	Amount awarded.
Wheat	15			
Oats	11			
Other Grain	119			
Totals		145	$153 50	$118 50
Potatoes, early	19			
Potatoes, late	24			
Other Vegetables	111			
Totals		154	118 50	90 00
Display of Vegetables		3	80 00	65 00
County Exhibits		2	300 00	100 00
Totals		304	$652 00	$373 50

Dairy.

Cheddar Cheese	12	$55 00	$47 25
Michigan Cheese	10	55 00	31 89
Young America Cheese	4	23 00	13 00
Fancy Cheese	2	12 00	8 00
Creamery Butter	9	90 00	90 00
Dairy Butter	24	45 00	45 00
Print Dairy Butter	12	20 00	18 80
Totals	73	$300 00	$253 94
Specials offered by Diamond Crystal Salt Co.	54		
Specials offered by Heller Merz Co.	17		
Sugar, Bread, etc.	38	53 00	37 00
Bees and Honey	13	133 00	55 00

Manufactures.

Wool	7	$30 00	$15 00
Furniture	9	Diplomas	3 Diplomas
Total	16		

Art.

Painting and drawing, professional	85	$487 00	$301 00
Painting and Drawing, amateur	24	85 00	31 25
Industrial Art	15	73 00	13 00
Curiosities	2	25 00	15 00
Total	126	$670 00	$363 25

Needle and Fancy Work.

Fine Needlework, professional	118	$133 25	$97 75
Fine Needlework, amateur	153	100 50	77 00
Needlework, miscellaneous	87	35 50	27 00
Crochet and Knit Work	91	20 25	18 25
Children's Work	25	20 00	9 75
Needlework, not enumerated	45	......	33 50
Totals	519	$318 90	$272 75
Special premiums by merchants of Pontiac	5	value	$9 50

Horticultural.

	Number entries.	Amount offered.	Amount awarded.
County Exhibit of Fruit	10	$300 00	$280 00
Artistic Exhibit of Fruit	6	41 00	35 00
General Collections, family use	10	60 00	60 00
General Collections, market	10	44 00	44 00
Special Exhibit Peaches	9	36 00	36 00
Special Exhibit Pears	9	36 00	33 00
Special Exhibit Plums	8	17 50	17 50
Special Exhibit Grapes	5	33 50	23 00
Single plates, Apples	315	77 50	62 50
Single plates, pears	94	37 50	21 50
Single plates, Peaches	66	33 75	29 00
Single plates, Plums	80	37 50	32 00
Single plates, Grapes	33	18 75	12 25
Single plates, Quinces	8	3 75	3 75
Single plates, Cranberries	3	3 75	1 50
Dried, Pickled and Preserved Fruits	14	100 00	100 00
Plants in pots, professional	48	184 00	136 00
Cut Flowers, professional	24	102 25	71 25
Plants, amateur	0	56 25	......
Cut Flowers, amateur	2	31 00	4 00
Non-enumerated	20	......	2 25
Totals	772	$954 00	$874 50

School Work.

High Schools	19	$179 50	$24 00
Village	1	119 00	2 00
Totals	20	$298 50	$26 00
Grand totals	4,914	$16,616 50	$10,291 94

STATEMENT OF THE BUSINESS COMMITTEE.

Executive Committee Expenses and Salaries.—Winter Meeting.

Date. 1901.	No. of voucher.	To whom and for what drawn.	Amount.	
Jan. 15	2	W. P. Custard, personal expenses	$4 00	
	4	Dexter Horton, personal expense	5 85	
	5	W. E. Boyden, personal expense	9 80	
	6	William Ball, personal expense	6 90	
	7	H. R. Dewey, personal expense	9 25	
	8	I. H. Butterfield, personal expense	5 05	
	9	R. D. Graham, personal expense	2 00	
	10	E. W. Hardy, personal expense	5 95	
	11	Eugene Fifield, personal expense	8 50	
	12	Frank Maynard, personal expense	5 90	
	13	L. W. Barnes, personal expense	6 15	
	14	F. E. Skeels, personal expense	10 02	
	15	John McKay, personal expense	8 30	
	16	H. H. Hinds, personal expense	11 00	
	17	M. P. Anderson, personal expense	10 60	
	18	C. A. Waldron, personal expense	6 78	
	19	F. L. Reed, personal expense	5 60	
				$121 65

Other Meetings.

Date.	No. of voucher.	To whom and for what drawn.	Amount.	
1901.				
May 2	26	H. R. Dewey, locating committee expenses	$29 34	
	27	W. E. Boyden, attending meeting	9 04	
	28	E. W. Hardy, attending meeting	8 53	
	29	William Ball, attending meeting	3 92	
	30	Frank Maynard, attending meeting	8 00	
	31	L. W. Barnes, attending meeting	8 98	
Apr. 26	32	R. D. Graham, committee expenses	24 80	
	33	William Ball, locating committee expenses	18 86	
" 30	34	Dexter Horton, personal expenses	4 15	
	35	W. P. Custard, locating committee expenses	24 34	
May 7	36	I. H. Butterfield, locating committee expenses	16 96	
" 10	37	M. P. Anderson, locating committee expenses	29 47	
June 9	43	H. H. Hinds, locating committee expenses	42 45	
Aug. 15	47	F. E. Skeels, locating committee expenses	23 33	
Sept. 4	51	H. R. Dewey, expenses	14 22	
" 27	77	F. L. Reed, expenses	17 84	
	78	Eugene Fifield, locating committee expenses	15 18	
" 28	90	W. E. Boyden, expenses	4 50	
	141	S. O. Bush, locating committee expenses	20 99	
	98	C. W. Young, treasurer, to pay salaries Ex. Com.	516 00	
Oct. 18	154	Frank Maynard, salary	30 00	
				$871 10

Business Committee Expenses.

June 9	43	H. H. Hinds, expenses	$19 64	
Sept. 3	50	H. R. Dewey, clerical services	60 00	
" 27	78	Eugene Fifield, expenses	66 64	
" 28	92	Eugene Fifield, expenses	24 50	
	96	H. H. Hinds, expenses	63 44	
Oct. 18	155	Eugene Fifield, gen'l supt., salary and expenses	281 65	
				515 87

President's Office.

Sept. 27	79	Ray Hart, ass't to president	$24 54	
" 28	85	J. W. Cochrane, ass't to president	31 15	
	99	M. P. Anderson, president, expenses	43 93	
	98	C. W. Young, treasurer, to pay president's salary	100 00	
Oct. 18	162	M. P. Anderson, president, expenses	8 16	
				207 78

Secretary's Office.

Apr. 1	25	C. W. Watkins & Co., secretary's bond	$7 50	
Sept. 3	53	I. H. Butterfield, expenses	60 59	
" 28	83	K. L. Butterfield, assistant	16 50	
	110	C. D. Cowles, clerk	19 89	
	140	I. H. Butterfield, clerk hire	56 89	
	149	I. H. Butterfield, expenses	1 13	
	150	I. H. Butterfield, expenses	48 53	
Oct. 18	152	I. H. Butterfield, salary	575 00	
Dec. 20	176	I. H. Butterfield, expenses	16 80	
1902.				
Jan. 29	182	I. H. Butterfield, expenses	5 13	
				807 96

Treasurer's Office.

1901.				
Sept. 28	109	N. E. Duell, horse and carriage	$4 00	
Oct. 18	163	C. W. Young, treasurer, expenses	129 92	
	164	C. W. Young, treas, pay roll help	218 50	
Dec. 30	177	C. W. Young, treasurer, salary	250 00	
				602 42

Date.	No. of voucher.	To whom and for what drawn.	Amount.	
		Cattle Department.		
1901.				
Sept. 28	90	W. E. Boyden, expenses supt. and judges........	$66 30	$66 30
		Horse Department.		
Sept. 28	95	Geo. Greer, asst. marshal.......................	$6 00	
	96	H. H. Hinds, superintendent, expenses and judge	38 09	
Dec. 31	178	W. S. Walker, assistant......................	15 00	
				59 09
		Speed Department.		
Jan. 15	3	Geo. S. Ward, clerk balance 1900...............	$27 25	
Sept. 24	55	Eugene Fifield, supt., race purses..............	1,200 00	
" 25	56	Eugene Fifield, supt., race purses..............	1,200 00	
" 26	59	Eugene Fifield, supt., race purses..............	1,200 00	
" 27	64	Eugene Fifield, supt., race purses..............	800 00	
	70	W. F. Adams, starting judge..................	28 90	
	71	John Carmody, soliciting entries...............	25 00	
" 28	86	Geo. S. Ward, clerk and expenses...............	142 39	
	91	Harry Van Auken, work on track.............	60 00	
	92	Eugene Fifield, board judge....................	9 50	
	94	J. F. Rundel, assistant and judge..............	20 00	
Aug. 17	125	American Trotting Association membership......	50 00	
				4,763 04
		Sheep Department.		
Sept. 27	67	William Ball, expenses superintendent.........	$26 80	
" 28	124	Peter Voorhees, judge and expenses............	2 50	
	126	D. P. Dewey, judge and expenses................	7 61	
" 27	152	J. J. Ferguson, judge and expenses............	28 45	
				65 36
		Swine Department.		
Sept. 27	74	M. McIntosh, judge and expenses.............	$37 30	
" 28	87	L. W. Barnes, supt., expenses..................	19 70	
				57 00
		Poultry Department.		
Sept. 27	73	C. A. Waldron, expenses supt. and judge........	$43 71	43 71
		Farm and Garden Department.		
Sept. 27	77	F. L. Reed, expenses supt. and judge...........	25 16	25 16
		Dairy and Apiary Department.		
Sept. 28	100	John McKay, supt., expenses.................	37 73	37 73
		Farm Implements and Machinery.		
Sept. 27	58	John A. Hoffman, supt., expenses..............	53 45	53 45
		Vehicle Department.		
Sept. 28	127	D. Horton, supt., expenses....................	27 10	27 10
		Manufactures and Main Building.		
Sept. 28	107	F. E. Skeels, supt., expenses..................	41 33	41 33

Art Department.

Date.	No. of voucher.	To whom and for what drawn.	Amount.	
1901.				
Sept. 28	138	A. H. Griffith, supt., services and expenses	$120 85	$120 85

Needlework Department.

Sept. 28	105	Mrs. S. Tobin, asst. judge, services and expenses	27 60	
	106	Mrs. S. Tobin, supt., services and expenses	25 95	
				53 55

Horticultural Department.

Sept. 27	113	M. L. Dean, judges, self and assistant	$20 00	
" 28	114	M. L. Dean, supt., services and expenses	62 48	
	156	Pontiac Cold Storage Co., storage	41 75	
				124 23

School Department.

Sept. 27	68	Frank Maynard, expenses supt	$25 10	25 10

Police.

Sept. 27	80	E. W. Hardy, expenses supt	25 25	
	88	E. W. Hardy, supt., pay roll	645 15	
" 28	92	Eugene Fifield, paid policeman extra	5 00	
				675 40

Gates.

Sept. 27	57	W. P. Custard, supt., pay roll	$156 83	
	76	W. P. Custard, supt., expenses	17 96	
" 28	109	N. E. Duell, horse hire	4 00	
				178 79

Privileges.

Sept. 28	97	H. R. Dewey, pay roll help	$115 81	115 81

Postage.

Feb. 18	20	I. H. Butterfield, sec., stamps	12 00	
Apr. 26	33	William Ball, stamps	4 00	
June 13	38	I. H. Butterfield, sec., stamps	26 20	
July 15	44	I. H. Butterfield, sec., stamps for premium list	100 00	
Sept. 3	49	I. H. Butterfield, sec., stamps and envelopes	61 12	
" 4	52	H. R. Dewey, stamps	62	
" 27	77	F. L. Reed, stamps	50	
" 28	92	Eugene Fifield, stamps	3 00	
	99	M. P. Anderson, stamps	10 00	
	107	F. E. Skeels, stamps	4 00	
	150	I. H. Butterfield, stamps	5 00	
Oct. 14	151	I. H. Butterfield, stamps	55 70	
Nov. 16	171	I. H. Butterfield, stamps and envelopes	22 18	
Dec. 20	176	I. H. Butterfield, stamps	4 00	
1902.				
Jan. 29	182	I. H. Butterfield, stamps	18 50	
				326 82

Printing and Stationery.

Date.	No. of voucher.	To whom and for what drawn.	Amount.	
1901.				
Feb. 14	21	Lawrence & Van Buren, circulars	$9 30	
“ 23	22	Powers, Tyson & Co, letterheads and envelopes	5 75	
June 13	40	Lawrence & Van Buren, letterheads and envelopes for offices	40 95	
Sept. 3	53	I. H. Butterfield, rubber bands	2 00	
“ 14	117	Powers, Tyson & Co., speed entry blanks and cards	31 00	
	117	Powers, Tyson & Co., button cards	5 00	
“ 30	128	C. W. Young, treas., to pay bills, tickets, entry book	29 75	
“ 28	129	Pontiac Gazette, sundry printing	58 25	
	133	C. & J. Gregory, tickets, passes etc	22 25	
	144	Brown Bros., stationery	5 93	
	148	I. H. Butterfield, stationery, paid	65	
	149	I. H. Butterfield, stationery	1 00	
Oct. 29	166	Oakland County Post	94 15	
Nov. 1	167	C. W. Young, treas., to pay bills	4 75	
Dec. 20	176	I. H. Butterfield, stationery	30	
				$311 03

Advertising.

July 1	42	T. G. Adams, advertising in Institute Report	$5 00	
Sept. 4	52	H. R. Dewey, paid distributing advertisements	2 00	
“ 28	83	K. L. Butterfield, expenses and services	60 10	
	90	W. E. Boyden, services and expenses	32 03	
	99	M. P. Anderson, paid bill posting	2 75	
July 23	102	Powers, Tyson & Co, lithographs	204 75	
“ 28	103	The T. W. Noble Co., banners	131 50	
	110	Chas. D. Cowles, distributing advertising matter	24 50	
“ 21	111	Stephen Middleton, distributing adv. matter	29 50	
Sept. 28	112	Andrew Dickinson, putting up advertising	8 00	
	115	C. W. Young, treas., to pay bills, advertising	73 88	
	118	Evening News Ass'n, adv. News and Tribune	150 00	
“ 13	120	Cal M. Gillette, bill posting in Lapeer county	24 75	
“ 11	121	Detroit Journal Co., illustrated page	325 00	
“ 17	122	Thos. Keys, bill posting	16 00	
“ 28	129	Pontiac Gazette, posters, cards, paper adv	208 50	
	130	C. W. Young, treas., to pay advertising bills	156 05	
	131	C. W. Young, treas, to pay bill posting	126 07	
	132	Geo. M. Savage, advertising in 112 papers	155 12	
	135	Detroit Free Press, advertising	122 00	
	137	Daily Abend Post, advertising	11 25	
	148	I. H. Butterfield, paid advertising	44 65	
Oct. 18	157	C. W. Young, treas., to pay bills	62 00	
	161	C. W. Young, treas, to pay bills	103 55	
“ 29	166	Oakland County Post, bills, posters and paper	171 35	
Nov. 1	167	C. W. Young, bills paid	23 95	
Sept. 15	168	A. H. Foster, advertising Farmer's Friend	25 00	
	169	Edgar Noble, distributing advertisements	18 00	
“ 24	170	Detroit Free Press, advertising	15 00	
Nov. 22	174	Chicago Horseman Co., adv't speed	17 00	
“ 23	175	C. W. Young, treas., adv't bills paid	13 24	
Dec. 20	176	I. H. Butterfield, adv't bills paid	5 62	
1902.				
Jan. 29	182	I. H. Butterfield, adv't bills paid	2 25	
				2,370 36

General Expense.

Date.	No. of voucher.	To whom and for what drawn.	Amount.	
1901.				
Aug. 15	46	Byron E. Hall, mileage book acct. Maccabee Day	$30 00	
Sept. 4	54	H. R. Dewey, expenses, travel and hotel.........	50 89	
" 27	72	Byron E. Hall, Maccabee drill premiums........	300 00	
	81	Peter Turney, amount overpaid on privilege.....	100 00	
" 28	93	Daniel Webster, sprinkling grounds............	15 00	
	104	F. J. Stewart, straw.........................	145 26	
	108	H. R. Dewey, services........................	29 90	
	112	Andrew Dickinson, services..................	20 00	
	126	D. P. Dewey, judge election..................	2 00	
Oct. 18	143	F. W. Burch, services and expenses............	25 80	
" 1	146	D. L. Davis, rent office......................	19 50	
Sept. 27	153	Alma Hinds, clerk...........................	20 20	
1902.				
Jan. 7	179	F. C. Wood, balance premiums 1892...........	34 91	
" 7	180	A. A. Wood, balance premiums 1892............	35 70	
" 15	181	Central Storage Co., chairs, rent and repair	9 85	
				$839 01

Buildings and Grounds.

1901.				
Sept. 29	69	F. E. Skeels, supt., labor on buildings..........	$79 50	
" 28	103	The T. W. Noble Co., decorating signs, tents, etc..	389 86	
" 28	107	F. E. Skeels, maps of Horse B, Art hall.........	3 50	
" 23	123	Central Storage Co., chairs for D. R...........	25 00	
" 28	136	Waite Bros. & Robertson, material.............	122 90	
	147	Melvin Sign Co., signs......................	20 00	
	150	I. H. Butterfield, paid for cleaning vaults.......	6 00	
Oct. 18	158	E. Howland & Sons, wire fence................	16 00	
	159	Oakland Co. Agrl. Soc., lumber and labor.......	350 00	
	160	E. Howland, cleaning and improving grounds...	200 00	
				1,212 76

Telegraph and Telephone.

June 13	39	I. H. Butterfield, paid W. U. Tel. Co...........	$1 93	
Sept. 3	53	I. H. Butterfield, paid telegraph...............	1 00	
" 28	99	M. P. Anderson, telephone and telegraph........	2 40	
	142	W. U. Tel. Co., telegraph.....................	10 00	
	150	I. H. Butterfield, sec., telephone..............	5 80	
Nov. 1	167	C. W. Young, treas., telephone bill paid.........	5 00	
Dec. 20	176	I. H. Butterfield, telegraph....................	1 85	
				27 98

Express and Freight.

June 13	41	Am. Ex. Co. Lansing, express on stationery.....	$4 54	
Sept. 4	52	H. R. Dewey, paid express on sundries..........	6 14	
" 3	53	I. H. Butterfield, express and dray.............	4 45	
" 28	89	Am. Ex. Co. Pontiac, express..................	14 38	
	149	I. H. Butterfield, sec., express and freight paid..	22 22	
	150	I. H. Butterfield, sec., express and freight paid..	1 00	
Nov. 1	167	C. W. Young, treas., express paid.............	75	
Dec. 20	176	I. H. Butterfield, express paid on diplomas......	55	
1902.				
Jan. 29	182	I. H. Butterfield, express.....................	65	
				54 68

Diplomas, Ribbons and Badges.

Date.	No. of voucher.	To whom and for what drawn.	Amount.	
1901.				
Sept. 3	48	Edson Moore & Co., ribbons for premiums	$45 36	
" 21	119	Armstrong Regalia Co., printing prize ribbons	54 54	
" 8	140	Spring Dry Goods Co., buttons	10 25	
Nov. 15	173	Calvert Lithograph Co., diplomas	25 00	
				$135 15

Music.

Sept. 27	75	Citizens' Band	$168 00	
" 28	101	K. O. T. M. Band	100 00	
				268 00

Attractions.

Sept. 27	60	Giant Quartette, music	$125 00	
	61	A. L. Van Norman, spiral tower	150 00	
	62	Millie Scott, aerial act	100 00	
	63	Jas. Adams, aerial act	100 00	
	65	Dunham & Wagner, horse and bicycle race	125 00	
	66	D. Meixell, balloon (one ascension)	40 00	
Sept. 28	82	G. H. Turk, fire team races	192 20	
	83	K. L. Butterfield, supt. attractions	12 00	
	84	Chas. E. Barber, bicycle race	25 00	
	116	H. Walker, diving horses	500 00	
	134	T. K. Harding, Bay City fire team	53 00	
				1,422 20

Sundry Expenses.

1901.				
Jan. 15	1	A. N. Albee, horse hire 1900	$2 50	
	17	M. P. Anderson, bill advertising, 1900	5 80	
Mar. 4	23	Jos. England, balance premium, 1892	41 64	
" 12	24	Bray Bros. & Loomis, balance premium, 1892	64 26	
June 13	39	I. H. Butterfield, sec., deficiency in weight butter and cheese	7 87	
July 30	45	F. L. Elliott, chairs for office	3 25	
Sept. 4	52	H. R. Dewey, sundries, desk, etc	11 45	
" 3	53	I. H. Butterfield, twine, etc	1 09	
" 28	92	Eugene Fifield, punches for gate keepers	5 00	
" 28	107	F. E. Skeels, sundry items	10 11	
" 11	139	Columbian Transfer Co., storage and cartage	10 83	
Oct. 18	145	E. J. Hallet, sundry articles	27 64	
Sept. 28	148	I. H. Butterfield, sec., sundry articles	13 45	
	149	I. H. Butterfield, sec., sundry articles	7 75	
	150	I. H. Butterfield, sec., sundry articles	13 68	
Oct. 18	165	C. E. Bird, salt	1 25	
Dec. 20	176	I. H. Butterfield, bills paid	4 00	
1902.				
Jan. 29	182	I. H. Butterfield, bills paid	5 50	
				237 07
		Total		$16,864 84

SUMMARY.

Executive Committee, winter meeting	$121	65
Other meetings and salaries	871	10
Business Committee	515	87
President's Office	207	78
Secretary's Office	807	96
Treasurer's Office	602	42
Cattle Department	66	30
Horse Department	59	09
Speed Department	4,763	04
Sheep Department	65	36
Swine Department	57	00
Poultry Department	43	71
Farm and Garden Department	25	16
Dairy and Apiary Department	37	73
Farm Implements and Machinery Department	53	45
Vehicle Department	27	10
Manufactures and Main Building	41	33
Art	120	85
Needlework	53	55
Horticulture	124	23
School	25	10
Police	675	40
Gates	178	79
Privileges	115	81
Postage	326	82
Printing and Stationery	311	03
Advertising	2,370	36
General expenses	839	01
Buildings and Grounds	1,212	76
Telegraph and Telephone	27	98
Freight and Express	54	68
Diplomas, Ribbons and Badges	135	15
Music	268	00
Attractions	1,422	20
Sundry	237	07
Total	$16,864	84

Two hundred and ninety-two premium vouchers amounting to $10,189.09 have been paid; copies of which are on file with the Auditor General of the State.

FINANCE COMMITTEE REPORT.

Your committee on finance wish to report that we have examined the books and vouchers of the treasurer and carefully checked the items of receipts and expenditures as reported in his annual statement and find the report correct.

We have also examined the accounts of the secretary, business committee and superintendent of privileges and find each of them as reported, correct.

Very respectfully,
EUGENE W. JONES,
FRANK MAYNARD,
JOHN McKAY,
Finance Committee.

The executive committee of 1901 adjourned sine die.

MEETING OF THE EXECUTIVE COMMITTEE OF 1902.

Wednesday February 19, 1902.

Called to order by the president.

Roll called. All members present except Mr. Ball, Mr. Baldwin and Mr. Horton, deceased since the fair.

The president read his address as follows:

Gentlemen of the Executive Committee:

It is with no little fear, mingled with pride, that I am able to again address you at your annual gathering. The past year has been an eventful one in the society's history. The change in location, attended with all the anxieties usual upon such occasions, has been passed through, and I need not tell you that the selection made by the committee appointed at the last annual meeting upon location was a wise one, as the financial standing of the society today will show.

While we are joyful over the financial success, we are pained at the loss from our membership the past year of the following esteemed and honorable gentlemen:

Hon. Wm. L. Webber, ex president and member ex officio, who died at Saginaw on the 15th day of October, 1901.

Hon. Wm. Chamberlain, ex president and ex officio member, who died at Chicago on the 7th day of November, 1901.

Hon. John Lessiter, one of the oldest active members, who died at the city of Pontiac on the 23d day of October, 1901.

Major Dexter Horton died at his home at Fenton, Mich., on the 28th day of December, 1901.

I trust suitable action will be taken by this body.

PREMIUM LIST.

The premium list was somewhat revised at last winter's meeting. I hope the premium list committee will look it over carefully and make such changes as their good judgment may dictate; that each superintendent will lend the committee such assistance as may make their departments more efficient.

RECEIPTS AND DISBURSEMENTS FOR 1901.

Balance on hand at close of 1900 business	$3,543 99	
Receipts from all sources	42,666 89	
		$46,210 88

DISBURSEMENTS.

Total business orders, including speed	$16,879 04	
Total premium orders	10,189 09	
Balance on hand	19,142 75	
Total		46,210 88

PRINTING AND ADVERTISING.

The plan adopted for the past three years has proved so beneficial that the plan should be continued.

TRANSPORTATION.

While transportation so far as it went was satisfactory, the traffic in passengers was so much beyond the expectations of both the steam and electric roads that many people were prevented from attending the last exhibition. As this is a mutual benefit to both society and transportation companies, I dare say ample provisions will be made for the next fair.

I would recommend the appointment of a suitable person to have charge of the transportation in and out of the grounds during week of the fair, assisting both exhibitors and visitors.

EXHIBITORS' TICKETS.

The plan adopted last year was an improvement over past years, and so far as I am able to learn it was very satisfactory.

EXHIBITS.

The exhibits for 1901 were well up to the standard. The exhibits from some of the northern counties were especially commendable, and I trust the society will extend to them the most liberal treatment.

ATTRACTIONS.

The plan adopted for a varied class of amusements in vogue the past year seems to be popular, as the grand stand receipts will verify.

BOOTHS AND PRIVILEGES.

This is undoubtedly one of the most vexatious departments to handle connected with the society. It requires skill, tact and good business judgment to handle this without friction and to make it a source of revenue. The veteran superintendent, Mr. Dewey, should be congratulated upon his successful handling of this department.

BUILDINGS AND GROUNDS.

The buildings, with the exception of some small ones needed, were ample and very well arranged. Check and toilet rooms should be ample and convenient for visitors. The grand stand, while apparently large enough, failed to supply the demand. A little change in way of privileges will give the public who are willing to pay for seats an opportunity to get one.

The grounds proved to be large enough and quite convenient. I would suggest that the plat in front of Howland Hall be kept free from booths and teams, and the grounds provided with a large tent with seats.

There should be a change made at entrance to dining hall, it being so close to ticket office and entrance to grand stand. Ample provision should be made to furnish eatables.

POLICE.

With the immense throng of people in attendance there was the best of police protection. The department had the personal supervision of the chief, assisted by a corps of experienced men.

IN CONCLUSION.

It is unnecessary to give any advice, as the members who have assisted in its management are all competent. We are situated much different at this time than we have been before in many years. The old craft that was floating upon the rough sea of financial difficulties has been safely guided by a brave, never-give-up set of business men; no deserters, no one jumped overboard; all pulled steadily at the oars overcoming all kinds of difficulties, until at last she is moored at the door of that old Chief "Pontiac."

While regrets are expressed at the retirement of some of the old associates at this time, we welcome the new members and trust that our relations will be both pleasant and profitable in the management of the society's work. The place for holding the 1902 exhibition having been settled, I trust the society will be successful in fixing dates that may prove satisfactory.

Last year I recommended the offering of special premiums for some of the northern counties of the lower peninsula, and through the generosity of the legislature, sanctioned by the Governor, the society was enabled to carry it out.

The exhibits that came from that portion of the State were of excellent quality and very commendable. I hope the policy of the society will continue to expand with liberal offerings until it shall reach every agricultural and horticultural portion of the State, the fundamental principle being to promote and encourage agriculture and its kindred arts.

M. P. ANDERSON.

The address of the president was referred to a committee, Mr. Hoffman, Mr. Collier and Mr. Hall.

The superintendent of privileges was directed to preserve copies of contracts.

The committee on the address of the president reported as follows:

Your committee to whom was referred the address of the president, cheerfully commend it as being wise and comprehensive. The committee further indorse the various recommendations which the president offers, and express the hope that the respective sub-committees will act on the lines suggested in his able address.

We would further recommend that a committee of three be appointed to draft suitable resolutions to the memory of deceased members: Hon. W. L. Webber, ex president, Hon. William Chamberlain, ex president, Mr. John Lessiter, member of the executive committee, and Major Dexter Horton, member of the executive committee, and that the resolutions be recorded in the minutes of this meeting.

Respectfully submitted,

JOHN A. HOFFMAN,
W. W. COLLIER,
BYRON E. HALL,
Committee.

The committee on rules reported a few changes in rules which were adopted.

The committee on premium list reported a list with several additions; among them Guernsey cattle, Angora goats and large Yorkshire swine. The fruit list was also increased.

The report was adopted.

On motion the speed department was authorized to offer $5,500 in 11 purses. The salary of the treasurer was fixed at $400, with bond for $20,000. The salary of the secretary was fixed at $800, with bond for $1,000. The premium on each bond to be paid by the society.

The secretary was directed to keep his office at Pontiac for 60 days previous to the fair, and that his expenses in doing so be paid.

On motion a committee of seven was appointed by the president to confer with the Oakland County Agricultural Society relative to a proposition to sell the fair grounds.

On motion the committee proceeded to elect a member in place of Mr. Dexter Horton, deceased.

On motion the secretary was directed to cast the ballot of the committee for Mr. E. W. Hardy. Ballot so cast and Mr. Hardy declared elected.

On motion the receipts from score card and pool privileges were directed to be credited to the speed department; the department also to have charge of letting the same.

Mr. Boyden moved that the Eastern Asylum for the Insane be requested to refund the amount paid in premiums on cattle at the fair. Adopted and referred to the superintendent of cattle.

The following offered by Mr. Skeels was adopted:

Resolved, That the chairman of the committee on transportation be made the superintendent of transportation and that it shall be his duty to give his entire attention to the transportation of people, express and freight to and from the grounds of the society during the week of the fair.

The following offered by Mr. Howland was adopted:

WHEREAS, The facilities for railroad transportation to the annual fair of 1901 proved inadequate, and the terminal facilities too small for the traffic; therefore

Resolved, That the Grand Trunk Railway system be respectfully requested to provide increased facilities for the transportation of freight and passengers to and from the fair, and also to enlarge the platforms and sidings at the fair grounds for unloading and reloading freight and passengers.

On motion proceeded to the election of general superintendent. Mr. Eugene Fifield received a majority of the votes cast and was declared elected.

A ballot for member of the business committee was taken. Mr. W. E. Boyden had 12 votes, Mr. W. P. Custard, 10 votes; Mr. H. H. Hinds, 1 vote. Mr. Boyden was declared elected.

The president announced superintendents and committees as follows:

STANDING COMMITTEES AND EXECUTIVE SUPERINTENDENTS

BUSINESS.

Eugene Fifield, W. E. Boyden and Secretary.

TRANSPORTATION.

Eph. Howland, H. H. Hinds, W. W. Collier.

PROGRAM.

H. R. Dewey, J. E. Rice and Secretary.

PRINTING AND ADVERTISING.

I. H. Butterfield, J. A. Hoffman, W. P. Custard.

RECEPTION.

Stephen Baldwin, W. W. Collier, John Marshall.

PREMIUM LIST.

W. E. Boyden, E. W. Hardy, L. W. Barnes, W. W. Collier,
W. P. Custard, Frank Maynard, C. A. Waldron.

RULES.

Eugene Fifield, H. H. Hinds, Geo. H. German.

FINANCE.

E. W. Jones, John McKay, B. E. Hall.

GENERAL SUPERINTENDENT.

Eugene Fifield.

CHIEF MARSHAL.

H. H. Hinds.

EXECUTIVE SUPERINTENDENTS.

Cattle—H. R. Dewey.
Horses, Speed—Eugene Fifield.
Horses, Roadsters, Draft and Pony Classes—H. H. Hinds.
Sheep—Wm. Ball.
Swine—L. W. Barnes.
Poultry—C. A. Waldron.
Dairy, Bees and Honey—John Marshall.
Farm and Garden Products—John McKay.
Vehicles—J. E. Rice.
Agricultural Implements and Machinery—John A. Hoffman.
Supt. Main Building—F. E. Skeels.
Manufactured Goods—F. E. Skeels.
Art—Byron E. Hall.
Needle Work and Children's Work—Mrs. F. E. Skeels, Harriette.
School Exhibits—Frank Maynard.
Horticulture—Geo. H. German.
Gates—W. P. Custard.
Police—E. W. Hardy.
Forage—Geo. H. German.
Concessions and Privileges—F. E. Skeels.
Miscellaneous Exhibits—John McKay.
Transportation—Eph. Howland.

MICHIGAN STATE GRANGE.

REPORT OF WORK OF THE ORDER OF PATRONS OF HUSBANDRY IN MICHIGAN FOR THE YEAR ENDING JUNE 30, 1902.

OFFICERS FOR 1901.

Master—G. B. HORTON, Fruit Ridge.
Overseer—N. P. HULL, Dimondale.
Lecturer—MRS. F. D. SAUNDERS, Rockford R. F. D.
Steward—T. E. NILES, Mancelona.
Assistant Steward—WM. ROBERTSON, Fremont.
Chaplain—MRS. MARY A. MAYO, Chelsea R. F. D.
Treasurer—E. A. STRONG, Vicksburg.
Secretary—MISS JENNIE BUELL, Ann Arbor.
Gate Keeper—G. A. WHITBECK, Montague.
Ceres—MRS. ANNA R. JONES, Lapeer.
Flora—MRS. VIRGINIA HALLADAY, Clinton.
Pomona—MRS. DELLA PROCTOR, Webberville.
Lady Assistant Steward—MRS. MARY ROBERTSON, Fremont.

EXECUTIVE COMMITTEE.

Thomas Mars, Chairman, Berrien Center	December,	1902
A. E. Palmer, Kalkaska	“	1902
M. T. Cole, Palmyra	“	1902
N. I. Moore, Jonesville	“	1902
F. W. Redfern, Maple Rapids	“	1903
E. A. Holden, Lansing	“	1903
Emory E. Owen, Lapeer	“	1903

G. B. Horton, Fruit Ridge, Jennie Buell, Ann Arbor, Ex-officio.

The past year has been full of activity among the Granges of the State. Not only has the work of organization gained rapidly but in every department increased vigor has been shown.

The progress of the departments of education, cooperation and legislation are so fully set forth in the State Master's last report to National Grange that the following paragraphs are quoted here:

"Educational work through the lecturers of subordinate granges is being improved and greatly strengthened by our systematic and business-like method of State supervision headed by the Lecturer of the State Grange. This officer is no more a traveling orator and organizer but instead a permanent home official operating from an executive basis to support, encourage and to point out the way. Through this method the inactive lecturers, from whatever cause, are located, and the necessary assistance rendered. Thus to a great degree Grange dormancy is prevented and our ranks preserved practically unbroken. This may be considered as mothering granges in a most practical way. Along the line of further exercising this paternal care so essential to Grange perpetuity in a state, we have established what may be termed a summer and a winter series of work. The summer series to consist of a systematic chain of what we propose to call 'Patrons' Rallies' arranged for on such successive dates as will permit our speakers to attend one each working day of a week. The same to be located by counties or districts, as will be most successful in calling out the rank and file of patrons everywhere to receive the encouragement and new enthusiasm so much needed always. The programs at these rallies are to be suggested and controlled in such a way as to keep Grange principles and thought in prominence to the end that the week may be strengthened, the strong kept steadfast,—so that the thoughts of those present and not members of the Order may be turned grangeward. We choose to call these gatherings 'Patrons' Rallies,' for the purpose of establishing their distinctiveness from the common farmers' picnics of which we have so many.

"The winter series consists of state aid to the subordinate granges in the form of what we call 'Grange Conferences,'—the conferences to be held even more numerously over the State than the 'Patrons' Rallies,' so as to go as near to the great mass of members as possible. In other words, go to the many good members who will not come to us at any great distance. These conferences to be in every sense what their name suggests. Have the meetings for patrons only. Meet at 10 a. m. and close at 4 p. m. Select from those present enough to open and close in ritualistic form for the purpose of comment if necessary, and the establishment of uniform methods all over the State. For consideration take up questions of Grange methods and procedure such as perfect degree forms, duties of officers, lecturer's hour, cooperate buying, unwritten work, and any of the many questions upon which Grange success depends. For the maintenance of this summer and winter series of State aid to subordinate granges, the State Grange pays such proportion of the expenses as may be decided upon and the treasury will warrant. Through this line of summer and winter work ingeniously carried out it is calculated that our State Grange can perform its full duties in the matter of mothering the subordinate granges. These plans substitute a business system for random and scattered effort. They put the work in such form as will permit the greatest possible amount of good to be done at a minimum cost. They are susceptible of such improved execution as management and new conditions and experience may dictate. Thus we avoid the demoralizing effect of trying something new at frequent intervals and much of the time doing practically nothing.

"Our system of cooperative trade through special contracts is of great importance to the Order of Michigan. The list contains about forty contracts with as many manufacturers and business firms. Extra from this are our special contracts for binder twine and fertilizers. While these contracts are not used by all granges and members of the Order they satisfy those who desire to receive the benefits of direct trade while there is no possible chance of injury from them to the Order. At the present our State Grange receives nearly enough in percentages from these contracts to pay the salaries of all its officers.

"The Michigan State Grange forced declarations favorable to the cause of equal taxation into the platforms of each of the dominant parties at the two last State elections. Its tenacity in the exercise of this strong influence has resulted in placing railroads and other corporate properties upon the assessment rolls at cash value same as the farms of the State, whereas before these remunerative properties were given the extraordinary privilege of paying a tax based upon earnings. Through the authority given our tax commission many millions of before hidden moneys and values are now placed upon the tax rolls of the State and the other properties are proportionately relieved. All of the pure food laws, which include the plain labeling of goods subject to adulterations and our anti-color law, stand to the credit of Grange legislative work.

"These worthy achievements and many others are the results of Grange influence upon legislation in our State.' It seems evident that if exact facts could be deducted from among the causes which have led to the prominence and popularity of the Grange in Michigan to-day, its influence favorable to just and healthy reforms in matters of legislation would stand out most prominent of all."

Michigan has led all the other states, the same as it did last year, in the number of its new granges organized. Last November an invitation to National Grange to hold its thirty-sixth annual session in Michigan was cordially accepted. This comes in recognition of long and persistent work in Michigan Grange circles. Wherever organization of the farmer has gone the needs and opportunity have widened before the organizer. The field has been whitening as education has had its beneficent effects.

JENNIE BUELL,
Secretary.

STATE ASSOCIATION OF FARMERS' CLUBS.

The State Association of Farmers' Clubs is still a potent factor in the State of Michigan. The good that it has accomplished cannot be estimated. One of the first aims of the association was the formation of new clubs—its aim in this direction has surpassed even the most sanguine expectations, and the good work along this line is still going on; some of course have dropped by the wayside.

While the number of local clubs is large, too small a per cent are members of the State Association; a club's membership being wholly voluntary; there being nothing compulsory about it.

The State Association is not a separate organization, it is the allied forces of the local clubs working conjointly; every club which gives it its support adds to its influence; any club that withdraws its support detracts from that influence.

Man is a social being, and a large per cent of his happiness is derived from an interchange of ideas with his fellows. Times have very materially changed since the days when our forefathers with the ox team visited their neighbors. Times and the situation are encroaching upon the farm, and demanding more and more of the citizens thereon. But those people with tact, energy and enthusiasm, the class that makes any enterprise move, are found in every community equal to the emergency, and meeting all demands intelligently without fear and trembling.

There was lacking to the farmer and his family social privileges. Necessity is a good master, and the Farmers' Club was born to fill this want, and its members are benefited mentally, morally and socially. Today in those communities in which exists a flourishing club, a farmer's life is rendered happier, richer and much more complete than ever before.

A few years ago the bushy roadside, the briar-grown fence corners were the rule, not the exception; today they are the exception, and not the rule, in those counties strong in the Farmers' Club movement—and the credit we believe is due to this organization; particularly to its itinerancy.

Organization is today the lever that moves the world. Let then the farmers continue to organize—be the power behind the throne—make yourselves felt in the business world—do your own thinking, do not let someone else do it for you; do not let yourselves be controlled wholly by the "bulls and bears."

The local clubs throughout the State are discussing live topics—not merely those pertaining to their own individual locality—but those of vital interest to every citizen of the State of the Lakes, and the United States as well. The clubs are discussing today measures that will benefit the farmer, and when the convention meets in annual session in December, the delegates will be prepared to present such measures as are deemed advisable, and the legislature when assembled next winter, will be requested to enact laws accordingly. By the combined effort of the grange and the Farmers' Club many laws are being enacted for the benefit of the farmers at every legislative session.

One thing that has been proven is this: No association of any craft carries more weight with it to the legislative body than does that of our organization, when united on any desired legislation.

The objects for which the association stands and is working at the present time are as follows:

1. The retention of the present tariff laws on sugar.
2. The election of United States senators by the direct vote of the people.
3. The government construction and ownership of a Pacific cable.
4. Opposition to granting of subsidies to steamship companies.
5. The enactment and enforcement of such laws as will effectually and permanently remove anarchy from our nation.
6. Opposed to the irrigation of arid western lands at public expense.
7. The adoption of the county salaries' bill and the Torren's land transfer system.
8. For such laws with regard to local option as will diminish the sale and use of intoxicating liquors.
9. To have a part of the State Tax Commission composed of representative farmers.
10. Extension of rural free mail delivery.
11. Government control of trusts.
12. Effectual pure food laws.

The association is officered as follows:

OFFICERS.

President—A. B. Cook, Owosso, R. F. D. No. 1.
Vice President—Mrs. Helen Landon, Albion, R. F. D. No. 1.
Secretary—Miss Julia Ball, Hamburg, R. F. D. No. 1.
Treasurer—Mrs. Mary Marshall, South Lyon.

DIRECTORS.

	Term expires.
C. E. Hadsell, Troy	1902
J. Sessions, Fowler	1902
J. T. Daniells, St. Johns	1903
C. M. Flumerfelt, Rochester	1903
L. C. Baker, Wolfcreek	1904
Capt. W. M. Horton, Fowlerville	1904

JULIA BALL,
Secretary.

INDEX.

46

INDEX.

A. Page.

Academic departments, board committee 5
Accessions to general museum, 1899-1902 45
Account current, 1901-1902 12
Account experiment station, 1901-1902 12
Account of secretary 10
Account of treasurer 10
Account salaries 13
Account special appropriations 11
Accounts of the State Agricultural College, 1901-1902 10
Aëration of milk, Chas. E. Marshall 259, 261
Agricultural College accounts, 1901-1902 10
Agricultural department, bulletin 193, beet pulp 111
Agricultural department, bulletin 197, sugar beets 186
Agricultural department, bulletin 198, sand lucerne 210
Agricultural department, bulletin 199, cow peas, soy beans and winter vetch 222
Agricultural department, report of 27
Agricultural Society, Michigan State, transactions 326-355
Allen, Edward P., member board of agriculture 5
Analysis of commercial fertilizers, R. C. Kedzie 304
Anderson, M. P., president's address State Agricultural Society 350
Appropriations, legislative, for college, 1855-1902 14
Athletic department, board committee 5
Atkins, Martin D., A. B., assistant professor of physics and electrical engineering 7
Atkins, Martin D., report of department of physics and electrical engineering 53
Avery, Sarah, S. B., instructor in gymnastics 8

B.

Babcock, Warren, B. S., assistant professor of mathematics 7
Bacteriologist and hygienist of experiment station, report of 78
Bacteriology and hygiene department, bulletin 201, aëration of milk 259
Bacteriology and hygiene department, special bulletin 16, aëration of milk 261
Bacteriology and hygiene department, report of 51
Baker, E. C., foreman of foundry 8
Baldwin, Julia M., clerk to secretary 8
Ball, Julia, report of State Association of Farmers' Clubs 361
Barrows, Walter B., S. B., professor of zoology and physiology 6
Barrows, W. B., accessions to museum, 1899-1902 45
Barrows, W. B., report of curator of the general museum 43
Barrows, W. B., report of department of zoology and physiology 39
Beal, Wm. J., A. M., M. S., Ph. D., professor of botany and forestry 6
Beal, Wm. J., report of department of botany and forestry 57
Beans, soy, cow peas and winter vetch, J. D. Towar 222

	Page.
Beet pulp as a stock food, C. D. Smith	111
Beet sugar experiments, 1901, J. D. Towar	186
Bird, Arthur C., B. S., M. Agr., secretary	6
Bird, Arthur C., secretary board of agriculture	5
Bird, Arthur C., secretary and treasurer experiment station	9
Blair, E. R., foreman of farm	8
Bliss, Governor Aaron T., member ex-officio board of agriculture	5
Blunt, Georgiana, Ph. M., assistant professor of English	7
Botanical department, board committee	5
Botany and forestry department, report of	57
Bourns, Walter C., feeding experiment	117
Bowd, E. A., architect	8
Bradford, W. R., foreman of wood shop	8
Brown, Addison M., A. B., secretary board of agriculture	5
Brown, A. M., secretary and treasurer experiment station	9
Brown, A. M., submission of annual report	3
Buell, Jennie, report Michigan State Grange	358
Buildings and property, board committee	5
Building, inventory	17
Bulletin No. 193, some experiments with beet pulp as a stock food, C. D. Smith	111
Bulletin No. 194, report of South Haven sub-station for 1901, S. H. Fulton	127
Bulletin No. 195, strawberry notes for 1901, L. R. Taft and M. L. Dean	157
Bulletin No. 196, notes on vegetables, L. R. Taft and M. L. Dean	165
Bulletin No. 197, sugar beet experiments, 1901, J. D. Towar	186
Bulletin No. 198, sand lucerne, J. D. Towar	210
Bulletin No. 199, cow peas, soy beans and winter vetch, J. D. Towar	222
Bulletin No. 200, some insects of the year 1901, Rufus H. Pettit	231
Bulletin No. 201, aëration of milk, Chas. E. Marshall	259
Bulletin No. 202, analysis of commercial fertilizers, R. C. Kedzie	304
Bulletin, special, No. 16, aëration of milk, Chas. E. Marshall	261
Bulletins of experiment station for fiscal year	111-325
Butterfield, I. H., report of secretary State Agricultural Society	337, 339

C.

Canker worm, the	248
Chemical department, board committee	5
Chemical department, bulletin 202, commercial fertilizers	304
Chemical department, report of	65
Civil engineering, mathematics and, report of department of	33
Class of 1902	23
College current account, 1901-1902	12
College financial accounts	10
College income, 1855-1902	16
College inventory, summary	17
College land grant, board committee	5
College legislative appropriations, 1855-1902	14
College, State Agricultural, faculty and other officers	6
Commercial fertilizers, analysis of, R. C. Kedzie	304
Committees, standing, of the board	5
Consulting entomologist of experiment station, report of	79
Consulting veterinarian of experiment station, report of	81
Cow peas, soy beans and winter vetch, J. D. Towar	222
Crowe, Belle C., instructor in domestic science	7
Curator of the general museum, report of	43
Current college account, 1901-1902	12

D.

Page.

Davis, B. F., treasurer board of agriculture 5
Dean, M. L., L. R. Taft and, notes on vegetables 165
Dean, M. L., L. R. Taft and, strawberry notes for 1901 157
Dean, M. L., station assistant in horticulture 9
Denman, Geo. E., director of physical culture 7
Denman, Geo. E., report of department of physical culture 53
Department, agricultural, report of 27
Department, mechanical, report of 37
Department, military, report of 64
Department of bacteriology and hygiene, report of 51
Department of botany and forestry, report of 57
Department of chemistry, report of 65
Department of drawing, report of 52
Department of English and modern languages, report of 54
Department of history and economics, report of 49
Department of horticulture and landscape gardening, report of 29
Department of mathematics and civil engineering, report of 33
Department of physical culture, report of 53
Department of physics and electrical engineering, report of 50
Department of practical agriculture, report of 27
Department of zoology and physiology, report of 39
Department reports, college 22-65
Department reports, experiment station 71-81
Department, veterinary, report of 54
Department, women's, report of 47
Diemer, Hugo, M. E., assistant professor of mechanical engineering 7
Director of experiment station, report of 71
Drawing department, report of 52

E.

Economics and history, report of department of 49
Edwards, Howard, M. A., LL.D., professor of English and modern languages 6
Edwards, Howard, report of department of English and modern languages 54
Edwards, S. Fred, B. S., instructor in bacteriology and hygiene 7
Edwards, S. Fred, station assistant in bacteriology and hygiene 9
Electrical engineering, physics and, report of department of 50
Employes and salaries 13
Employes, board committee 5
English and modern languages, report of department of 54
Entomological department, bulletin 200, insects of 1901 231
Entomologist, consulting, of experiment station, report of 79
Experiments, sugar beet, J. D. Towar 187
Experiment station account, 1901-1902 12
Experiment station, advisory and assistant staff 9
Experiment station, board committee 5
Experiment station bulletin No. 193, beet pulp 111
Experiment station bulletin No. 194, fruits 127
Experiment station bulletin No. 195, strawberries 157
Experiment station bulletin No. 196, vegetables 165
Experiment station bulletin No. 197, sugar beets 186
Experiment station bulletin No. 198, sand lucerne 210
Experiment station bulletin No. 199, cow peas, soy beans and winter vetch 222
Experiment station bulletin No. 200, insects of 1901 231
Experiment station bulletin No. 201, aëration of milk 259
Experiment station bulletin No. 202, commercial fertilizers 304
Experiment station bulletin No. 16 (special), aëration of milk 261

	Page.
Experiment station bulletins for fiscal year	111-325
Experiment station council	9
Experiment station disbursements	69, 70
Experiment station inventory, summary	21
Experiment station, report of consulting bacteriologist and hygienist	78
Experiment station, report of consulting entomologist	79
Experiment station, report of consulting veterinarian	81
Experiment station, report of director	71
Experiment station, report of horticulturist	75
Experiment station, report of secretary and treasurer	69
Experiment station sub-stations	9

F.

Faculty and other officers	6
Farmers' clubs, State Association of	361
Farmers' institutes, board committee	5
Farm management, board committee	5
Farrand, T. A., in charge of South Haven sub-station	9
Faunce, B. A., clerk to president	8
Ferguson, John J., B. S. Agr., instructor in animal husbandry	7
Fertilizers, analysis of commercial, R. C. Kedzie	304
Finance, board committee	5
Financial report of secretary	10
Forestry, botany and, report of department of	57
Fulton, S. H., B. S., in charge of South Haven sub-station	9
Fulton, S. H., report of South Haven sub-station for 1901	127

G.

Geismar, L. M., feeding experiment	114
Geismar, L. M., in charge of upper peninsula experiment station	9
Gilchrist, Maude, B. S., dean of women's department	6
Gilchrist, Maude, report of women's department	47
Grain aphis, the	244
Grange, Michigan State	356
Grayling sub-station, location	9
Gunson, Thos., instructor in floriculture and foreman of greenhouse	8

H.

Haner, Mrs. Jennie L. K., instructor in sewing	7
Hedrick, U. P., M. S., assistant professor of horticulture	7
Hedrick, W. O., M. S., assistant professor of history and political economy	7
Hedrick, W. O., report of department of history and political economy	49
Hinman, Clara A., bookkeeper	8
History and economics, report of department of	49
Holdsworth, Wm. S., M. S., assistant professor of drawing	6
Holdsworth, Wm. S., report of department of drawing	52
Holt, Caroline L., instructor in drawing	7
Horticultural department, board committee	5
Horticultural department bulletin 194, report of South Haven sub-station	127
Horticultural department bulletin 195, strawberries	157
Horticultural department bulletin 196, vegetables	165
Horticultural department report	29
Horticulturist experiment station, report of	75
Humphrey, Geo. C., B. S., instructor in animal husbandry	8
Hygiene, bacteriology and, report of department of	51
Hygienist, bacteriologist and, experiment station, report of	78

I.

Page.

Inch-worm, lime tree 251
Income of college, 1855-1902 16
Insects of the year 1901, some, R. H. Pettit 231
Inventory of college property, summary 17
Inventory of experiment station property, summary 21

J.

Jeffery, Jos. A., B. S. Agr., assistant professor of agriculture 7
Jeffrey, Jos. A., report of department of agriculture 27

K.

Kedzie, Frank S., M. S., adjunct professor of chemistry 6
Kedzie, Robt. C., M. A., M. D., D. Sc., LL.D., professor of chemistry 6
Kedzie, R. C., analysis of commercial fertilizers 304
Kedzie, R. C., chemist of experiment station 9
Kedzie, R. C., report of department of chemistry 65
Kenney, Fred C., cashier 8
Ketchum, Rowena, in charge of college hospital 8
King, E. Sylvester, instructor in English 7

L.

Land grant, college, board committee 5
Landon, Mrs. Linda E., librarian of college 7
Landon, Mrs. Linda E., librarian of experiment station 9
Landon, Mrs. Linda E., report of librarian 60
Legislative appropriations for college, 1855-1902 14
Leonard, W. S., foreman of machine shop 8
Library, board committee 5
Library, report of librarian 60
Lime-tree inch-worm 251
Locke, Leslie L., M. A., instructor in mathematics 7
Longyear, Burton O., instructor in botany 7
Lucerne, sand, J. D. Towar 210
Lyford, Carrie A., B. L., instructor in cookery 7

M.

Marshall, Chas. E., Ph. B., assistant professor of bacteriology and hygiene 7
Marshall, Chas. E., aëration of milk, bulletin 201 and special bulletin 16 .... 259, 261
Marshall, Chas. E., bacteriologist and hygienist of experiment station 9
Marshall, Chas. E., report of bacteriological department 51
Marshall, Chas. E., report of bacteriologist and hygienist of experiment station 78
Marshall, Mrs. Maud A., instructor in music 7
Marsh, Hollister F., member board of agriculture 5
Marston, Thos. F., member board of agriculture 5
Mathematics and civil engineering department, report of 33
Mechanical department, board committee 5
Mechanical department, report of 37
Meteorological observations at M. A. C. for 1901 84
Meteorological observations at M. A. C., summary of, for 1901 83
Michels, John, B. S. Agr., instructor in dairying 7
Michigan State Agricultural Society, executive committee 326
Michigan State Agricultural Society, financial committee report 350
Michigan State Agricultural Society, meeting of executive committee of 1902 350
Michigan State Agricultural Society, officers 326
Michigan State Agricultural Society, president's address 350

Page.

Michigan State Agricultural Society, proceedings of the executive committee....... 328
Michigan State Agricultural Society, report of secretary....... 339
Michigan State Agricultural Society, report of treasurer....... 338
Michigan State Agricultural Society, reports of executive superintendents....... 332
Michigan State Agricultural Society, standing committees and executive superintendents....... 327, 354
Michigan State Agricultural Society, statement of business committee....... 342
Michigan State Agricultural Society, the fair of 1901....... 330
Michigan State Agricultural Society, transactions....... 326-355
Michigan State Agricultural Society, winter meeting of the executive committee.... 330
Michigan State Grange, report of secretary....... 356
Michigan weather service, report of....... 62
Military department, board committee....... 5
Military department, report of....... 64
Milk, aëration of, Chas. E. Marshall....... 259, 261
Monroe, Chas. J., member board of agriculture....... 5
Museum, report of curator of....... 43
Myers, Jesse J., B. S., instructor in zoology....... 7

N.

Newell, L. F., engineer....... 8
Newman, Chace, instructor in mechanical drawing....... 7
Notes on vegetables, L. R. Taft and M. L. Dean....... 165

O.

Onion-maggot, the barred-winged....... 253

P.

Parrott, Alfred H., M. A., instructor in mathematics....... 7
Peach lecanium, the....... 237
Peach lecanium, the large....... 239
Pea louse, the destructive....... 247
Peas, cow, soy beans and winter vetch, J. D. Towar....... 222
Pettit, Rufus H., B. S. Agr., instructor in zoology....... 7
Pettit, R. H., consulting entomologist experiment station....... 9
Pettit, R. H., report of consulting entomologist experiment station....... 79
Pettit, R. H., some insects of the year 1901....... 231
Phigalia Strigataria 252
Physical culture, report of department of....... 53
Physics and electrical engineering, report of department of....... 50
Physiology, zoology and, report of department of....... 39
Plum, apricot scale on....... 231
Plum gouger, the 254
Potato beetle, the old fashioned....... 257
President's report 22

R.

Report of bacteriologist and hygienist experiment station....... 78
Report of consulting entomologist station....... 79
Report of consulting veterinarian station....... 81
Report of curator of general museum....... 43
Report of dean of special courses....... 56
Report of department of bacteriology and hygiene....... 51
Report of department of botany and forestry....... 57
Report of department of chemistry....... 65
Report of department of drawing....... 52

Page.
Report of department of English and modern languages 54
Report of department of history and economics 49
Report of department of horticulture and landscape gardening 29
Report of department of mathematics and civil engineering 33
Report of department of physical culture 53
Report of department of physics and electrical engineering 50
Report of department of practical agriculture 27
Report of department of zoology and physiology 39
Report of director experiment station 71
Report of horticulturist experiment station 75
Report of mechanical department 37
Report of military department 64
Report of secretary and treasurer experiment station 69
Report of South Haven sub-station for 1901, S. H. Fulton 127
Report of the librarian 60
Report of the Michigan weather service 62
Report of the president 22
Report of veterinary department 54
Report of women's department 47
Reports, department 22-65
Report, secretary's financial 10
Report, treasurer's 10
Reynolds, Herman W., B. S. in M. E., instructor in mechanical engineering 7
Robison, F. W., B. S., station assistant in chemistry 9

S.

Salaries account 13
Sand lucerne, J. D. Towar 210
Schneider, C. F., report of Michigan weather service 62
Schneider, C. F., weather service director 9
Secretary and treasurer experiment station, report of 69
Secretary's financial report 10
Severance, Geo., B. S., instructor in agriculture 8
Sherman, Henry, foreman of grounds 8
Smith, Clinton D., M. S., dean of short courses, college extension lecturer and superintendent of institutes 6
Smith, C. D., director experiment station 9
Smith, C. D., experiments with beet pulp as a stock food 111
Smith, C. D., report of director experiment station 71
Smith, C. D., report of special courses 56
Snyder, Jonathan L., A. M., Ph. D., president of the college 6
Snyder, J. L., ex-officio member board of agriculture 5
Snyder, J. L., ex-officio member station council 9
Snyder, J. L., president's report 22
Some experiments with beet pulp as a stock food, C. D. Smith 111
Some insects of the year 1901, R. H. Pettit 231
South Haven sub-station, location 9
South Haven sub-station, report for 1901, S. H. Fulton 127
Soy beans, cow peas and winter vetch, J. D. Towar 222
Special appropriation account 11
Special courses, report of dean 56
Standing committees; board of agriculture 5
State Agricultural College, faculty and other officers 6
State Agricultural Society, Michigan, transactions 326-355
State Association of Farmers' Clubs, report of secretary 361
State Board of Agriculture; members of 5
State weather service, board committee 5, 9
State weather service, officers 9
Stevens, Philip H., A. B., instructor in English 8

Page.

Stock food, beet pulp as a, C. D. Smith ... 111
Strawberry notes for 1901, L. R. Taft and M. L. Dean ... 157
Students, summary of ... 24
Sugar beet experiments, 1901, J. D. Towar ... 186
Sugar beets, clover root mealy bug on ... 242

T.

Taft, Levi R., M. S., professor of horticulture and landscape gardening ... 6
Taft, L. R., and M. L. Dean, notes on vegetables ... 165
Taft, L. R., and M. L. Dean, strawberry notes for 1901 ... 157
Taft, L. R., horticulturist experiment station ... 9
Taft, L. R., report of department of horticulture and landscape gardening ... 29
Taft, L. R., report of horticulturist experiment station ... 75
Taylor, A. H., instructor in physics ... 7
Theadore, Paul, foreman of forge shop ... 8
Towar, J. D., B. S., agriculturist experiment station ... 9
Towar, J. D., cow peas, soy beans and winter vetch ... 222
Towar, J. D., sand lucerne ... 210
Towar, J. D., sugar beet experiments, 1901 ... 186
Treasurer's account ... 10
Treasurer, secretary and, of experiment station, report of ... 69

U.

Upper peninsula experiment station, location ... 9
United States appropriation for experiment station disbursements ... 70

V.

Van Wormer, L. H., B. S., station assistant in chemistry ... 9
Vedder, Herman K., C. E., professor of mathematics and civil engineering ... 6
Vedder, H. K., report of department of mathematics and civil engineering ... 33
Vegetables, notes on, L. R. Taft and M. L. Dean ... 165
Vernou, Major Chas. A., U. S. A., professor of military science and tactics ... 6
Vernou, Major Chas. A., report of military department ... 64
Vetch, winter, cow peas, soy beans and, J. D. Towar ... 222
Veterinarian, consulting, of experiment station, report of ... 81
Veterinary department, report of ... 54

W.

Waterman, Geo. A., V. S., M. D. C., professor of veterinary science ... 6
Waterman, G. A., consulting veterinarian of experiment station ... 9
Waterman, G. A., report of consulting veterinarian of experiment station ... 81
Waterman, G. A., report of veterinary department ... 54
Watkins, L. Whitney, member board of agriculture ... 5
Weather service, annual report of ... 62
Weather service, State ... 9
Weil, Chas. L., S. B., professor of mechanical engineering ... 6
Weil, Chas. L., report of mechanical department ... 37
Wellman, Bertha M., B. S., B. Pd., instructor in English ... 7
Wells, Franklin, member board of agriculture ... 5
Wells, Walter W. B. S., instructor in mechanical engineering ... 8
Wheeler, Chas. F., B. S., assistant professor of botany ... 7
Wheeler, Chas. F., consulting botanist of experiment station ... 9
Winter vetch, cow peas, soy beans and, J. D. Towar ... 222
Women's department, board committee ... 5
Women's department, report of ... 47

Y.

Young, C. W., report of treasurer State Agricultural Society ... 338

Z.

Zoological department, report of ... 39

New York Botanical Garden Library
3 5185 00259 1236